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THE RELATIONSHIP BETWEEN ADRENAL WEIGHT AND POPULATION STATUS OF URBAN NORWAY RATS

BY JOHN J. CHRISTIAN AND DAVID E. DAVIS

It has been proposed that changes in the size of animal populations exert density-dependent effects on the physiology of individuals in these populations (Christian, 1950). Theoretically, the magnitude of the physiological alterations would increase with increases in population size until there is a cessation of population growth followed by a decline or, in extreme cases, a population crash. Emphasis was placed on the adaptive reactions of the pituitary-adrenocortical and reproductive systems to density-dependent stimuli which were presumably sociopsychological in nature. Therefore these stimuli would be effective throughout the history of a population, changing only in magnitude with changes in population size. Environmental hardships, such as food shortages and disease, of necessity would be imposed on and additive to this basic response to density.

A direct relationship between adrenal weight and population density was demonstrated in the laboratory with albino and wild house mice in populations of fixed size (Christian, 1955*a*, *b*). A similar relationship was demonstrated in freely growing populations of wild house mice maintained in the laboratory (Christian, 1956). Increases in adrenal weight resulted primarily from cortical hypertrophy. Subsequently it was shown that the adrenal weights of wild Norway rats decreased following an artificial reduction of population (Christian and Davis, 1955). Finally, the subordinate rats of a group, as determined by losing fights, exhibit increased adrenocortical activity with eventual cortical hypertrophy (Barnett, 1955). The latter work suggests a sociopsychological mechanism by which population density might be related to adrenal activity in rats.

None of these experiments has demonstrated a corresponding relationship between population density and adrenal weight in natural populations. The present experiments were designed to examine natural populations for such a relationship.

The opinions or assertions contained herein are the private ones of the writers and are not to be construed as official or reflecting the views of the Navy Department or the naval service at large.

METHODS AND PROCEDURE

The rats (*Rattus norvegicus*) in 21 blocks of Baltimore City were used. Each city block is effectively an island and its rats form a discrete population unit, since immigration and emigration of rats is negligible or absent (Davis, 1953). The rats obtain their food from the abundant and relatively constant supply of garbage available in the back yards. Harborage is found in and around houses, fences, trash piles, and old buildings, and its availability remains fairly constant unless a housing rehabilitation program is in progress. These city blocks provide numerous discrete populations of rats ideal for the study of population phenomena under natural conditions. The quantitation of environmental factors is still a major problem, however, which has been discussed in detail by Davis (1953) along with the effects of environmental variation on rat populations. Food and harborage were believed to be adequate in all of the blocks used in the present experiment.

Each block population selected for study had a long history of repeated censuses by the method of Emlen, Stokes, and Davis (1949). This method cannot reliably detect population changes of less than 10 per cent. This degree of insensitivity is unimportant in the present experiment, since relatively large changes in population usually were used, and for the most part these were produced artificially or stimulated by trapping. The histories of the rat populations in these blocks were used to estimate maximum values for the populations as well as to assign a stage of growth for each population, whenever a

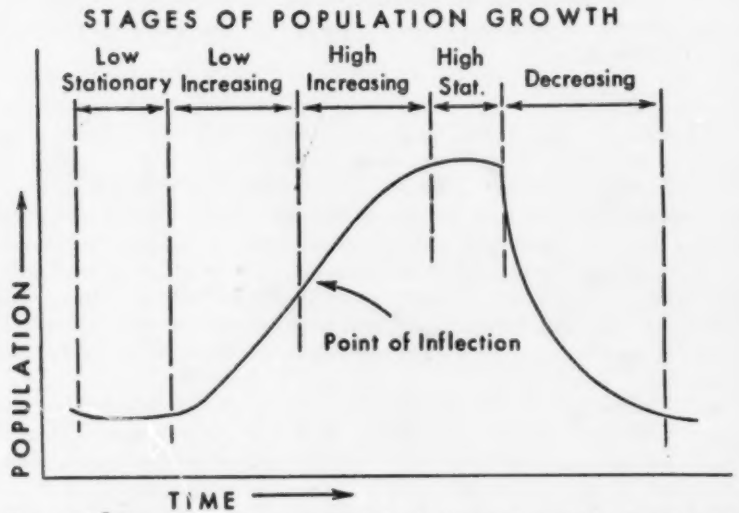

FIG. 1. Hypothetical growth curve divided into stages of population development as described in the text. Each population of rats was placed in one of the five population stages at the time of collecting each sample.

sample was taken, by estimating in which portion of a hypothetical growth curve the population lay immediately prior to trapping. The growth curve used (Fig. 1) was composed of a sigmoid positive increasing portion succeeded by a high stationary phase of indefinite length and finally a decreasing phase, and broadly conformed to the general growth form of populations (Allee, Emerson, Park, Park, and Schmidt, 1949). Experience has shown that such a general curve is sufficiently close to the observed facts so that its various stages may be applied to rat populations, even though it is not precisely defined at present. The curve was divided somewhat arbitrarily into the following stages: low stationary, low increasing, high increasing, high stationary, and decreasing as shown in Figure 1. One of us (D. E. D.) assigned every population to one of these stages each time it was sampled. The same author also made all of the censuses for this study.

Bimonthly censuses were made of each population for at least a year prior to the start of the present program in March, 1952. The following procedure was followed between March, 1952, and February, 1953. The population was estimated and a week later approximately 50 per cent of the rats were trapped, and another census was made about two weeks later. The rat populations were initially selected so that they were high increasing, high stationary, or decreasing, and were large enough for adequate sampling. Six weeks later another census was made and another sample trapped, providing samples in the low stationary and low increasing categories. Another sample was trapped at varying intervals of time later, depending on the history of the particular population. The dates of trapping, population stages, and other pertinent data are given in Table 1. The assigned population stages can be considered only reasonably close approximations because of the limitations of quantitating the various factors of the environment and of the population itself for natural populations.

Subsequent to February, 1953, samples were taken and stages assigned without necessarily repeating the procedure following the initial trapping for the earlier populations. Block populations were programmed for further study which in some instances had to be abandoned because of the inability to obtain samples of adequate size. These blocks are self-evident in Table 1.

The weight in decigrams, length from the tip of the nose to the base of the tail in centimeters, and reproductive status were determined for each rat in the laboratory. The carcass was placed in 10 per cent neutral formalin. At a later date the weights of the paired adrenal glands, paired thyroid glands, pituitary gland, and thymus were obtained on torsion balances to the nearest 0.1 milligram for all but the pituitary, which was weighed to the nearest 0.01 milligram. Representative sections of these glands and of the various visceral organs of rats from the first group of populations studied were taken for microscopic study. They were prepared by routine paraffin imbedding and stained with hematoxylin and eosin. Four rats with obvious pathological conditions that might affect the adrenal weight were discarded from further consideration. Three rats had adrenal medullary tumors and one had a renal abscess.

TABLE 1.—*Dates of collection, preceding estimates of population size, and the sizes of the sample trapped of male and female Norway rats from Baltimore city blocks together with the mean adrenal values (see text) for each sex, grouped according to population stage*

Block no.	Date trapped	Pre-trap popn. est.	No. of females, >100 gm. in sample	Adrenal wt. as mean % of ref. values	No. of males, >100 gm. in sample	Adrenal wt. as mean % of ref. values
		Low Stationary Populations				
070421	May 52	45	7	95.81	3	130.07
070513	Oct. 52	48	7	103.29	8	97.45
140158	May 52	10	0	—	2	105.85
140220	May 52	48	12	89.92	7	118.57
140222	May 52	45	14	100.01	9	105.05
140226	June 52	47	10	89.25	5	124.84
140344	June 52	20	2	91.55	6	114.88
		Low Increasing Populations				
070421	Dec. 52	85	4	96.90	8	90.69
070426	Nov. 52	120	15	95.07	23	79.69
080750	May 52	15	4	92.48	2	84.15
140111	Nov. 52	43	12	79.67	7	84.93
140118	May 52	47	3	69.03	2	80.00
140132	Feb. 53	75	4	76.20	7	92.09
140138	July 52	59	15	98.63	14	102.31
140201	May 52	63	10	110.52	14	101.35
140222	Dec. 52	75	19	95.61	13	93.58
140222	Feb. 53	76	8	96.51	9	102.11
140226	Oct. 52	66	5	100.72	4	92.68
140332	Feb. 53	44	3	101.37	2	92.95
		High Increasing Populations				
070410	May 52	46	5	102.64	0	—
070410	Dec. 52	88	9	105.82	11	93.51
070421	Mar. 52	90	13	103.64	17	101.69
070506	Oct. 52	43	5	81.80	3	97.63
140111	Dec. 53	150	6	92.23	0	—
140118	Mar. 52	77	9	96.32	7	99.13
140118	Mar. 53	100	22	101.52	19	102.37
140158	Nov. 52	34	11	107.96	2	79.85
140201	Jan. 53	88	13	122.94	20	99.09
140201	Dec. 53	135	0	—	6	104.42
140220	Jan. 53	90	15	100.32	16	110.89
140222	Dec. 52	90	0	—	5	93.82
140344	Jan. 53	35	5	91.88	0	—
140134	Dec. 53	140	6	94.78	0	—
		High Stationary Populations				
070411	Mar. 52	35	8	93.79	2	119.65
070505	Mar. 52	49	6	110.15	7	88.70
070513	Feb. 53	63	16	124.89	8	79.21
110403	Dec. 53	80	0	—	6	137.40
140132	Oct. 52	45	10	79.36	3	114.63
140138	Nov. 51	75	17	86.39	11	111.74
140220	Mar. 52	81	15	107.06	12	118.66
140222	Apr. 52	75	13	110.01	13	98.28
140226	Apr. 52	67	4	107.50	11	115.25
		Decreasing Populations				
070410	Mar. 52	153	25	117.65	38	102.98
080750	Mar. 52	30	8	102.19	4	94.88
140158	Mar. 52	35	17	112.54	3	112.33
140201	Mar. 52	92	20	119.28	14	102.18
140322	Apr. 52	81	18	109.01	12	114.68
140322	June 52	58	12	97.17	5	108.16
140344	Apr. 52	58	13	114.95	14	130.69

Microscopic study was abandoned after February, 1953. Leptospirosis, Salmonellosis, and infestations of *Capillaria* are exceedingly common in the rats of Baltimore City. Studies by Davis (1951) indicate that the prevalence of Salmonellosis and Leptospirosis is the same for increasing, stationary, and decreasing populations; so that these diseases would not affect the present study. The same holds true for Capillariasis in rats weighing more than 199 grams. The vast majority of rats in this study were above this weight, and none was used that weighed less than 100 grams. The collection of thyroid, thymus, and pituitary weights was abandoned at the same time as the microscopic studies.

The rats varied from 100 to more than 600 grams; hence it was necessary to find a relationship between adrenal weight and body size which would permit the use of rats of every size in any sample, as the number of rats in most samples would not permit further subdivision into weight classes. Several transformations of the data were tried and the best straight line relationship was found to be the logarithm of the adrenal weight on the body length exclusive of the tail. A regression of the logarithm of the adrenal weight on length was determined for each sex, using over 1000 urban and rural rats from a variety of population densities, to obtain a standard line for reference. With few exceptions the rats in the present study comprised the urban rats used in determining these regressions. The equations for the regressions and their graphical representations are given elsewhere (Christian and Davis, 1955). There was no detectable difference between the urban and rural rats in the relationship of the logarithm of adrenal weight to length for either sex. A reference adrenal weight was determined for each body length for each sex from the regressions, and the adrenal weight of each rat in the study was converted to a percentage of the reference value for the appropriate length and sex. A mean value was determined from the individual percentages for each sex in every sample trapped (Table 1).

The unit of measurement used throughout this study is the mean value of the particular organ for the rats trapped in each block. Analyses of variance (Snedecor, 1946) were used throughout this study for evaluating the data unless otherwise specially noted.

RESULTS

Adrenal glands.—The adrenal values, given as the means of the individual percentages of reference weights for each sex and sample, are grouped according to the stage of population growth (Table 1) together with the sample sizes for each sex and the estimated number of rats in the population immediately prior to trapping. The mean adrenal values for each sample are shown plotted against the appropriate assigned stage of population growth (Fig. 2). The mean value for each sex and stage and its standard error are also shown.

There was a significantly greater variation in the mean adrenal values between stages than within stages of population growth for each sex (Females: $P < 0.02$; males: $P < 0.001$), indicating that changes in adrenal weight (relative to body length) are associated with the stages of population development.

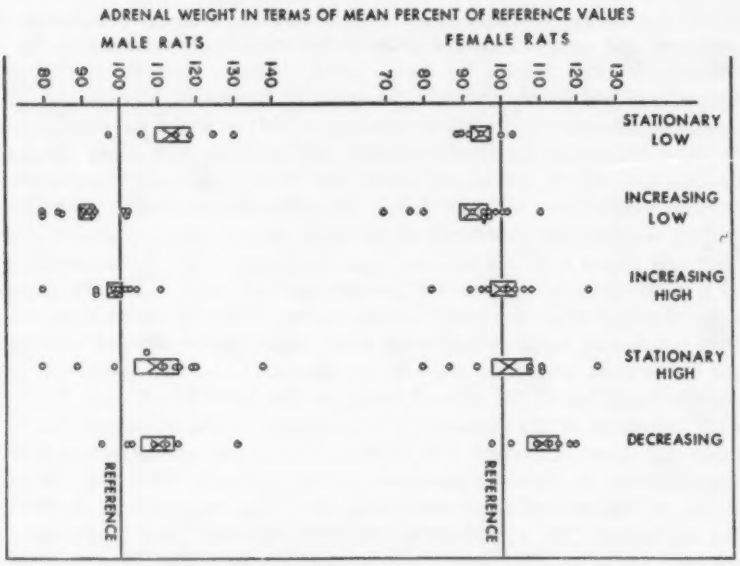

FIG. 2.—The mean adrenal value for each sex for each sample (shown as a circle) of Norway rats plotted on the population stage. The mean adrenal value for each population stage is also shown (as an X) with its standard error.

It is apparent that the adrenal glands of male and female rats responded alike to all stages of population except the low stationary (Table 2, Fig. 2). There was a progressive increase in the mean adrenal value from both sexes starting with the low increasing populations, progressing through the high increasing and high stationary stages, and ending with an overall 18 per cent increase in adrenal value in the decreasing populations. The mean change in adrenal weight value was approximately 6 per cent per stage of population (Fig. 2).

The adrenal glands differed markedly with respect to sex in their response to low stationary population status. The adrenal values of the female rats from these populations were essentially the same as those from low increasing populations and were therefore close to the lowest weights observed. On the other hand, the highest mean adrenal weight value of the male rats was for the low stationary stage, exceeding the mean adrenal value for the decreasing stage, although not significantly. It is quite apparent that there is a fundamental difference with respect to sex in the stimuli to the adrenal cortices in low stationary populations of urban rats.

The population stages have been arranged, in Table 3, in such an order that, according to the hypothesis proposed in this paper, the mean adrenal weights would be expected to increase from left to right. It will be observed that this is the case with only one exception. Moreover, since the various rows of the table confine the results to very small time intervals, the effect noted within

TABLE 2.—*Mean relative weights of the adrenal, thymus, thyroid and pituitary glands for each stage of population for Norway rats from Baltimore City blocks*

Stage of population	Sex	Number of samples	Paired adrenal wt. as mean % of ref. values ± std. error	Mean thymus wt., mg/100 gm. ± std. error	Mean pituitary wt., mg/100 gm. ± std. error	Mean paired thyroid wt., mg/100 gm. ± std. error
Low stationary	F	6	94.97 ± 2.35	117.0 ± 40.3	4.48 ± 0.25	12.30 ± 0.72
	M	7	113.82 ± 4.41	71.7 ± 12.4	4.29 ± 0.88	11.44 ± 1.39
Low increasing	F	12	92.73 ± 3.43	85.0 ± 9.2	3.91 ± 0.30	12.40 ± 0.48
	M	12	91.38 ± 2.31	59.2 ± 8.8	2.79 ± 0.02	11.79 ± 0.72
High increasing	F	12	100.15 ± 2.94	80.6 ± 12.1	4.11 ± 0.62	11.68 ± 0.65
	M	10	98.24 ± 2.62	76.8 ± 14.6	2.77 ± 0.07	12.06 ± 0.44
High stationary	F	8	102.39 ± 5.23	73.1 ± 11.5	4.48 ± 0.49	12.79 ± 0.80
	M	9	109.28 ± 5.40	70.9 ± 13.4	3.91 ± 0.56	11.94 ± 0.76
Decreasing	F	7	110.40 ± 3.90	58.0 ± 16.7	4.38 ± 0.54	12.47 ± 0.77
	M	7	109.41 ± 4.35	53.7 ± 9.9	3.50 ± 0.49	12.40 ± 1.12

TABLE 3.—*The mean adrenal value of both sexes for each population stage and month of capture. Months represented by only one population stage and all low stationary populations have been excluded*

	Low increasing	High increasing	High stationary	Decreasing
October	92.8	89.7	97.0	—
November	84.8	93.9	99.6	—
December	94.2	97.4	137.4*	—
February	91.7	—	102.1	—
March	—	100.8	106.3	108.0
April	—	—	107.8	117.3

* Represents a single value.

any single row is independent of seasonal change. Thus if there is any seasonal effect it does not affect the trends noted within the rows of this table. Low stationary populations were omitted because of the marked difference between male and female adrenal weights. Months represented by a single population stage were likewise omitted.

Thymus gland.—There was a suggestive decrease in the weights of the thymus glands of female rats from low stationary through decreasing population stages (Table 2, Fig. 3). The variation in thymus weight with population stage was not significant, nor was the difference between the extremes of the means. There was no suggestion of a pattern of weight change with population stage in the thymus glands of male rats. The thymus weights of the two sexes did not differ significantly.

Pituitary gland.—The mean pituitary weight relative to body weight (milligrams/100 grams) with its standard error is given for each population stage

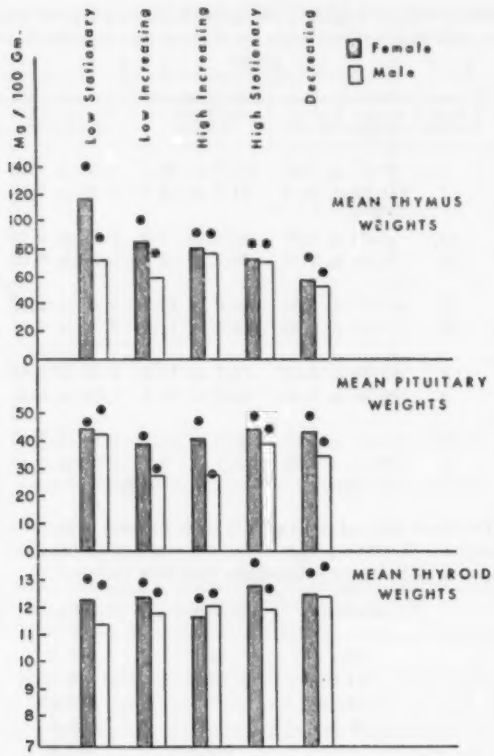

FIG. 3.—The mean weights and their standard errors in milligrams per 100 grams of body weight of the thymus, thyroid, and pituitary glands of Norway rats plotted for each population stage for each sex.

for each sex (Table 2). The relative pituitary weights were consistently greater in the female than in the male rats ($P < 0.01$) (Table 2, Fig. 3). The relative pituitary weights of the female rats showed no significant variation with population stage. The variation with population stage in the relative weights of the male pituitary glands appeared to parallel roughly the changes in adrenal weight (Fig. 3), but these changes were without significance. However, regressions of male mean adrenal values on relative pituitary weight and vice versa had slopes significantly different than zero ($P < 0.001$) suggesting positive relationship between the weights of the adrenal and pituitary glands of the male rats.

Thyroid gland.—There was no detectable relationship between thyroid gland weight and population stage (Table 2). The weights of the thyroid glands from male and female rats were not significantly different.

DISCUSSION

Intraspecific competition has been assigned a major role in regulating and limiting population growth (Allee, Emerson, Park, Park, and Schmidt, 1949). It has been shown that such competition between animals of the same species becomes more pronounced as populations increase and is manifested by decreased reproduction, growth, and survival (Davis, 1949; Calhoun, 1950). It is generally assumed that food, harborage, or other environmental necessities impose the limits on population growth and that intraspecific competition is to a large extent the medium through which these factors operate. It was suggested, however, that population growth might be limited purely by social competition in spite of an abundance of all of the usual environmental necessities (Christian, 1950). Presumably such sociopsychological pressures, as indeed they would have to be, would act as density-dependent stimuli to the pituitary-adrenocortical axis producing a progressive enlargement of the adrenal cortex and reduction in reproduction as the population increased. A point finally would be reached when a failure of reproduction would result in a failure of population growth. The animals in such a population presumably would be extremely susceptible to any additional insult. A decline in population might be expected to result from an additional burden which was beyond the ability of the animal to cope with it.

In order to verify such an hypothesis it was necessary to show that there is a density-dependent adrenocortical response independent of supplies of food, water, and harborage. Experiments in the laboratory with fixed and freely growing populations of white and wild house mice established the existence of such a mechanism, using the weights of the adrenal glands and reproductive organs as indicators (Christian, 1955*a*, *b*, 1956). The amount of adrenocortical tissue was shown to be positively related to the level of population. The present experiments are an extension of experiments with laboratory populations designed to establish whether adrenal weight (as a measure of cortical mass) was related to population status under natural conditions.

There was a positive relationship between the weights of the adrenal glands adjusted for body length and stages of population growth for urban Norway rats. There was a progressive increase in adrenal weight in both sexes as population status progressed from low increasing, through high increasing and high stationary, to decreasing. The adrenal glands in decreasing populations were 18 per cent heavier than in low increasing populations. These changes in adrenal weight occurred over and above any possible seasonal variation, although a seasonal effect could not be ruled definitely in or out. So far these data fit our hypothesis and coincide with the results of experiments in the laboratory, as increases in adrenal weight occurred with stages of population growth in spite of an excess of the usual environmental necessities. The marked difference between the sexes in their adrenocortical responses to low stationary populations is difficult to interpret. One would expect a decrease in adrenal weight following a decrease in population and the release of density-dependent social pres-

sures resulting in very low adrenal weights in low stationary populations. Apparently this is true for female rats, but not for males. The reason for male rats attaining their greatest adrenal weight in low stationary populations is not known. It may be that there is considerable strife among the males in these populations, perhaps resulting from reestablishing their social orders following a decrease in population. If so, it is hard to explain why the adrenal weights of male rats decreased following an artificial 50 per cent reduction in population size (Christian and Davis, 1955). However, the changes in adrenal weight in these experiments were on the whole predictable from the assumption that density-dependent sociopsychological factors operate as stimuli to the pituitary-adrenocortical system. Evidence that such social factors exist in rats has been presented by Barnett (1955) and Calhoun (1950). Frank (1953), in discussing his studies on experimental crashes in *Microtus* populations, has suggested that such a mechanism is operative, but that a final additional insult is necessary to initiate a precipitous crash with the syndrome of hypoglycemic shock when a population attains a peak level.

The alterations in adrenal weight in the present experiments were attributed to changes in adrenocortical mass. The adrenal medulla of rats does not contribute to changes in adrenal weight (Rogers and Richter, 1948), consequently changes in weight must result entirely from changes in cortical mass. Furthermore, adrenal weight was shown to be directly related to cortical mass and in turn to population size in mice (Christian, 1955*b*, 1956).

The apparent decrease in the weights of the thymus glands of female rats with increasing population density (and adrenal weight), although not significant, is suggestive of the thymico-lymphatic involution usually associated with increased adrenocortical function (Selye, 1950). A direct relationship between the weights of the pituitary and adrenal glands was seen in the male, but not in the female rats. This difference cannot at present be explained.

Throughout these experiments there was a considerable degree of variability which may have obscured the significance of changes in the weights of some of the organs. Unfortunately such variability is unavoidable with the presently available unprecise techniques for working with wild populations and their environment. The greatest error occurs in the stationary populations where estimation of the population status is least critical. Rapidly increasing or decreasing populations are usually clearly defined, but slowly changing populations may be erroneously classified as stationary, as their changes may be too small to be detected by the methods used. However, such errors in classification would do no more than place the population in one category higher or lower than its correct one. It is assumed that any such errors which may have been made are randomly distributed and have little effect on the final results.

The variability in adrenal weight throughout the experiment (Table 1) prompted further thought on the population mechanics of these rats. The population of rats in each block is composed of discrete colonies that tend to merge as the population increases, whereas they remain quite discrete at low levels of population. It may be that each colony acts as a discrete population in

its effect on the adrenal cortex; for example, one colony may be a dense population while another in the same block may be just the opposite. Grouping such diverse colonies into a single value for each block would tend to increase the variability in the results. This problem needs to be examined further, as a preliminary analysis suggests that each colony indeed acts as a discrete population unit. Any colony effect in the present experiments has been overridden by the use of a large number of populations and population samples.

SUMMARY AND CONCLUSIONS

There was a significant relationship between the weights of the adrenal glands relative to body length and population status in 49 samples of Norway rats from 21 blocks in Baltimore City. The adrenal glands of both sexes increased regularly in weight as the population status progressed along a hypothetical growth curve in successive stages from low increasing, through high increasing and high stationary, to decreasing stages. The adrenal glands in decreasing populations were approximately 18 per cent heavier than in populations that were in the low increasing stage. Male and female rats reacted differently to populations in the low stationary category. The adrenals of male rats were heaviest in these populations, while those of the female rats were essentially the same weight as in low increasing populations. The changes in adrenal weight with population status were on the whole consistent with the concept that there is a density-dependent sociopsychological stimulus to the pituitary-adrenocortical system that may be a major factor in the regulation of population growth. The changes in adrenal weight could not be attributed to seasonal variation.

There was a significant positive relationship in male rats between the relative weights of the pituitary and adrenal glands which was not observed in the female rats. A decline in the weight of the thymus gland of female rats with increasing population density and adrenal weight was suggestive but not significant. No relationship was found between population status and the pituitary glands of male rats or the thyroid glands from either sex.

It is concluded that there is a density-dependent stimulus to the pituitary-adrenocortical system of wild Norway rats that operates independently of season or supplies of the usual environmental necessities.

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Naval Medical Research Institute, National Naval Medical Center, Bethesda, Maryland; and The Division of Vertebrate Ecology, The Johns Hopkins School of Hygiene and Public Health, Baltimore, Maryland. *Received January 16, 1956.*

THE MIGRATIONS OF A MOOSE HERD

BY R. YORKE EDWARDS AND RALPH W. RITCEY

This paper was derived from study, for six years, of moose (*Alces alces*) in Wells Gray Park, British Columbia. Part of this work involved study of the annual migrations of these animals between lowland burns with deciduous vegetation and coniferous forests with few burns among them at higher elevations.

A number of mammals are known to be migratory. Hamilton (1939) notes that whales and seals of several species, some bats, caribou, bison, elk, mule deer, mountain sheep and porcupine undertake migrations. The last four move mainly in relation to altitude. Hatter (1946) has noted that moose are migratory in parts of British Columbia, while Hosley (1949) quotes Palmer's reports, on moose in Alaska, which describe seasonal movements similar in many respects to those in Wells Gray Park.

Moose ascend the Clearwater Valley in spring when snow is still present on the valley floor. Data on spring migration is obtained from counting moose tracks crossing a snowshoe trail. Tracks are counted daily, are recorded as to direction, then are marked to avoid inclusion in subsequent counts. This technique has been used in California and Oregon for deer (Interstate Deer Herd Committee, 1954). The fall migration is not so easily observed. Its progress on the valley floor is more leisurely, with movement continuing downward throughout the winter. Some information concerning this movement is available from hunting statistics gathered in autumn, while track counts and general observations provide further data.

The main objective of these track counts in spring is a partial census of the herd. The first movement north, up the valley, is rather sudden and involves over a thousand animals. Since this first movement is quite variable as to calender date, means for predicting the time of migration are necessary for efficient operation of the track counting project. This paper is a result of studying migration patterns, and seeking environmental conditions that control them. Casual observation indicated that weather was probably the major influence. Closer study has confirmed this hypothesis.

The vegetation and topography of this park has been described briefly in a previous paper (Edwards, 1954). Part of the park is within a region of relatively heavy precipitation known generally throughout the province as the Interior Wet Belt, where lowland coniferous forests have striking similarities with some forests on the humid Pacific Coast. Summer rainfall is frequent, and winter snow depths are deep, with much variation due to elevation, aspect, slope, and vegetation. Over six feet of snow may accumulate at sub-alpine elevations. The moose migrate away from this high ground in winter toward lower, warmer, drier winter range.

Most of the spring fieldwork necessitated long hours on snowshoes in wet snow, and was done by J. Norman, C. Gaglardi and R. Miller, all with the B.C. Forest Service.

Migration.—The movements undertaken by moose are true migrations, comparable in all respects to the altitudinal migrations of mule deer and elk on mountainous range. We consider migrations to be spatial oscillations, repeated at seasonal intervals, undertaken by animals to utilize different environments in such a way that detrimental conditions experienced are reduced to a minimum. Thus migration has survival value.

Altitudinal migrations are ecologically similar to the more familiar latitudinal migrations. They differ only in the distances involved. The migration of some Wells Gray Park moose from timberline to conditions approaching Douglas fir parkland, and involving map distances of about 40 miles, is ecologically similar to their moving some 350 miles from tree line in Canada's Northwest Territories to the fringes of the taiga in central Saskatchewan.

Annual pattern of distribution.—In general the annual distribution of the Wells Gray moose herd shifts from summer range in sub-alpine forests of alpine fir (*Abies lasiocarpa*) and Engelmann spruce (*Picea engelmanni*) at roughly 5,000 to 7,000 feet elevation, to winter range in lowland burns at elevations from 2,500 to 4,000 feet, which are rich in deciduous browse species. Part of this migration takes place down the gentle slope of the valley floor. While some moose find these seasonal ranges only a few miles apart and migrate up and down the steep sides of the valley, the majority follow more gradual slopes. For some animals the distance between winter and summer ranges is over 40 miles.

The segregation of winter and summer range is not complete. A few moose summer in ranges heavily populated in winter, while some survive in winter in forests supporting substantial summer populations.

Moose rarely inhabit extensive alpine meadows. The bulk of the herd summers in sub-alpine forest up to timberline. Preferred areas are wet from seepage with meadows among the trees, or about high burns. Moose summering in those deciduous burns used more heavily in early winter also favour poorly drained areas about meadows.

In the autumn there is movement to lower elevations. In warm weather there may be little movement until after October. Even casual observations reveal variation in this downward movement, and that cold weather with snow has some connection with migration. A wintery autumn will bring moose into low elevations in early October.

December usually finds them still on the highest of the lowland burns (3,000 to 4,000 feet above sea level) on the valley floor. The rest of the winter is a period of gradual descent down the gradient of the broad valley. In general this movement is slow, with occasional periods when it temporarily ceases altogether. All of this winter migration is through open, deciduous growth, rich in browse.

The return migration to higher elevations begins in April. The change in direction of migration may be abrupt, the slow drift downward changing over-

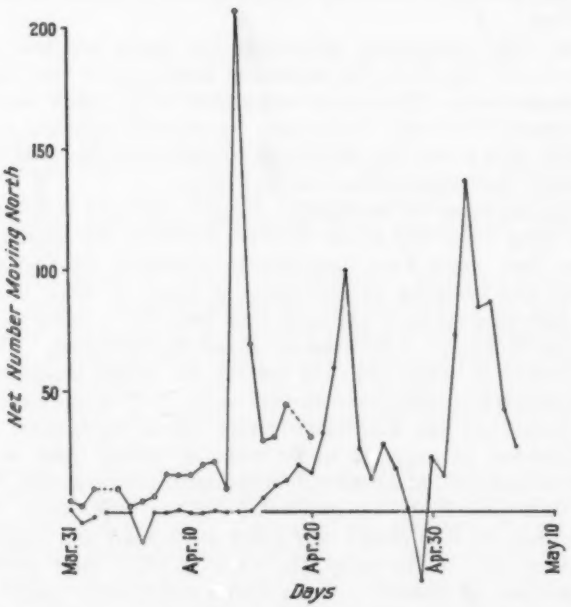

FIG. 1.—Net figures from daily counts of tracks in the spring of two years, 1952 (open dots) and 1954 (solid dots). Values above zero indicate most movement was upward; values below indicate most movement was downward. Zero values indicate either no movement, or equal movement up and down.

night to rapid movement up the valley. Some moose may still be drifting downward while the first movement upward is in progress.

While movement up the valley begins with a rush, its pace slows later and becomes more leisurely—a slow infiltration of summer range as spring ascends the mountain slopes. Perhaps the autumn migration is similar, the slow movement noted on the valley floor being preceded by a more rapid initial phase as yet unobserved.

This outline of moose migration is general. The essential elements are present every year, but each year appears to have its peculiarities in timing and rapidity of movement. Data from track counts in the spring illustrate this variability.

Spring migration.—Spring track counts were undertaken for four years, 1952 to 1955 inclusive. The Clearwater River runs from north to south, so that movement northward is movement to higher elevations, but of course has little significance with respect to latitude. In every year termination of the count has coincided with lack of sufficient snow to record tracks.

Figure 1 illustrates the variability found in these migrations. Data for two years, 1952 and 1954, are presented. Net movement only is shown. Equal numbers of moose going north and south result in no net movement for the period involved. This figure illustrates the variations observed in dates of migration and duration of movement. In 1952 most migration took place in a few days and was nearly over by mid-April. In 1954 migration was still in progress in early May. In this year there were two peaks of northward movement with a lull between. This pattern, with two distinct periods of movement, was noted in 1953 and 1955 as well. In this lull between peaks in 1954, there was one 24-hour period when net movement reversed. It was south for this brief period.

The difference in pattern of migration in the two years discussed may be due in part to 1952 figures being obtained about four miles down the valley from, and 500 feet lower than, where figures for 1954 were gathered.

Figures indicating net movement are insufficient for a full understanding of the migration. Gross figures are better. Those for 1954 are shown in Figure 2. In that year there was a period from the start of counting to April 6 in which movement up and down the valley was recorded, but there was little difference between the magnitudes of north and south counts. There followed nine days with virtually no movement of any kind. Northward migration probably began on April 16 and climaxed April 23. A lull in northward movement followed which was accompanied by maximum southward movement. Another peak in movement to higher ground followed, climaxing May 2. With increased movement northward, there was evidence of increased numbers of southbound tracks throughout. Much of this increase was due to wandering, accompanying feeding activity, by moose numbers that had been increased in the vicinity of the line by northward migration.

Gross figures for 1953 and 1955 exhibit some important differences from 1954 data. In 1953 northward movement began April 2. From March 10 to 31 there was a drift southward which then changed abruptly to northward migration. In both 1953 and 1955 there were two peak periods of northward movement

just as in 1954. In 1953, the lull between was still a period of considerable northward migration, so it is a lull only in the relative sense. In 1955 part of the lull contained a brief period when almost no tracks were recorded.

There are no gross figures available for 1952, apparently the only year in which northward movement was not interrupted.

Generalizing then, the slow downward drift of moose throughout the winter may continue to within a few days of migration upward. The upward movement comes to a rapid peak which may be interrupted with a second peak following. Not all movement is upward, even when upward movement is maxi-

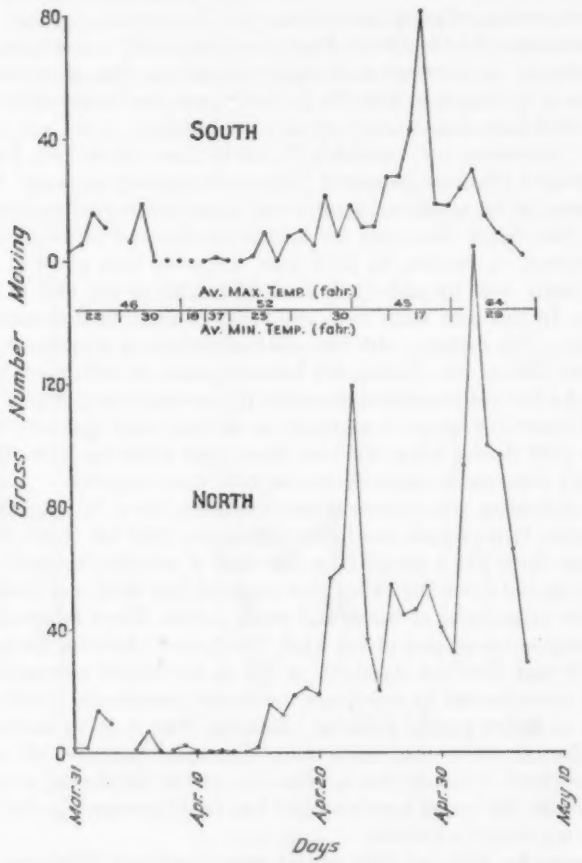

FIG. 2.—Gross figures from daily counts of tracks in the spring of 1954. The curve for 1954 in Figure 1 is derived from these gross curves. Temperature data indicate similar periods of maximum and minimum Fahrenheit readings and the figures shown are averages of maxima and minima in the periods concerned (see text).

mum. In one year the direction of migration reversed for a brief period between upward maxima.

Figure 2 shows maximum and minimum temperatures (Fahrenheit) for the track counting period in 1954. Figures shown are average for periods selected as having more or less similar readings. Maximum and minimum temperatures are only roughly indicative of temperature conditions generally, but are the best figures available for this study.

Study of Figure 2 reveals that the interruption of migration upward in 1954 was accompanied by a period of cold weather. Movement slowed with a drop of maximum temperatures into the forties and, later, a series of cold nights in the tens. With the return of warmer weather migration resumed. Similar weather changes accompanied the lulls in migration in 1953 and 1955. In both years, dropping temperatures to maxima in the forties and minima in the tens were associated with a slowing of upward movement, and in both years a return of warmer weather with maxima in the sixties and minima in the high twenties accompanied a second peak of upward movement.

Since cold weather stopped migration in three successive years, and the return of warm weather appeared to start it again, it is logical to suspect that warm weather initiated these migrations in the first place. It is evident from Figure 2 that migration began in 1954 during a period of maximum temperatures in the fifties. Three warm nights with temperatures well above freezing preceded by almost a week the appearance of large numbers of moose crossing the counting line. The counting line was about five miles above the range supporting the most moose when upward movement began, and this may account for the lag between rapid thaw and first recorded migration in numbers. Intervening weather of cooler nature may have contributed to this lag also. In 1953, an extended warm period culminated in a 24-hour thaw on March 30. Large numbers of moose crossed the counting line five days later in spite of somewhat cooler weather. In 1952, the counting line was four miles south of the line used subsequently. A thaw April 11–14, with rapidly melting snows, resulted in over 200 moose crossing the line in the 24-hour period prior to the morning of April 14. In 1951 general field observations indicated that moose began moving upward on April 3 and were moving "in a steady stream" on April 4. There had been a marked thaw March 29–31.

In one respect this agreement between temperature and migration data does not hold for 1955. The first half of April was warm with maximum temperatures in high fifties, minima in the high twenties. There was no upward migration in this period. The weather became colder April 17 and thereafter warmed gradually to minima in the thirties by April 21. The first migration in numbers was recorded April 21. Related to this behaviour is a condition evident in all years. In all winters there are periods of relatively warm temperatures with melting snows that result in no upward migrations. It must be concluded that temperature is not the only factor controlling migration.

Snow depth appears to be a factor associated with temperature in this respect.

There follows semi-monthly snow depth readings on moose winter range, 1951–2. Descending moose reach this elevation in numbers in February.

On December 1 snowdepth was 0 inches; on December 15, 8 inches; January 1, 17 inches; January 15, 19 inches; February 1, 17 inches; February 15, 20 inches; March 1, 25 inches; March 15, 20 inches; April 1, 16 inches; and April 15, 0 inches. Other records confirm that this data is typical in its trends for the winters of concern in this study. An initial rapid increase of snow depths in early winter is followed by a more gradual increase until March, with a rapid decrease thereafter.

On the track counting line, mean snow depths were about 20 inches or more at the beginning of the count each year. In all years mean snow depths decreased throughout the counting period. Migration upward (for the four years 1952–1955 inclusive) was always associated with snow depths of a foot to a foot and a half and decreasing rapidly. First large movements were in mean snow depths of 18, 18, 12 and 16 inches respectively. Also, in 1955, four miles down the valley from the counting line, first evidence of movement upward was noted in about 16 inches of snow, and first migration involving large numbers of moose took place in 12 inches of snow.

Snow is a major environmental variable affecting the survival, and hence the survival behaviour, of many animals. Moose require large quantities of food for survival, and deep snow increases the energy output necessary to obtain adequate nourishment. Snow appears to be a major controlling factor in moose migration, and may be the factor preventing movement to higher elevations during warm periods in winter. Thus in 1955, in spite of warm temperatures through the first half of April, there was no migration because snow depths were too deep. In 1954 (Fig. 2) the warm period April 4 to 9 occurred when snow was about 20 inches deep, and there was no migration upward.

The slow drift of moose down the valley throughout the winter coincides with a period of increasing snow depths. Rapidly melting snow in spring coincides with rapid migration upward.

Temperature is the basic factor involved. It acts partly through its influence upon snow conditions. Temperature alone may be important, however, since cold weather slowed migration upward in three successive years.

Fall and winter migration.—Data from hunter success during the period September to December, both months partly inclusive, provide general information on moose migrations in fall and early winter. In addition, a short track counting line has been maintained from early January to mid-April in 1954 and 1955.

Hunter success data are available for three years. Figures for 1952 and 1953 are remarkably similar. In these years moose became increasingly numerous in the higher burns on the valley floor throughout the hunting periods. For example, in 1953, from September 20 to December 14 in four successive twenty-day periods and a final seven day period, the numbers-of-days-hunting required to bag a moose were, successively, 31, 23, 17, 10 and 7. In 1954, by contrast, an average of 25 days was required to bag a moose up to December with little variation through this period. In December only nine days were required.

TABLE 1.—*Total moose track counts, along a short snowshoe trail, in half month totals, 1954*

Period	Tracks down	Tracks up
Jan. 1–15	16	3
16–31	14	4
Feb. 1–15	51	1
16–28	2	3
Mar. 1–15	20	9
16–31	0	0
Apr. 1–15	0	1
16–20*	0	28

* No snow after this date.

The difference in hunter success between the two years is a reflection of fewer moose upon the ranges used in early winter. These are the most heavily hunted areas. Fewer moose in 1954 coincides with shallower snow depths. Snow depths on these ranges averaged over a foot at the close of the hunt in 1953, but averaged only two inches the following year.

Track counts in winter indicate irregular migratory movement downward until spring, with heaviest movement in February at the elevation of the counting line. The month of heaviest movement would vary, of course, with the elevation at which data are collected. Table 1 presents these track counts for 1954, and illustrates the irregular nature of this downward drift. Movement downward is indicated until mid-March. In 1955, downward movement continued until April.

The critical snow depth beyond which moose find survival difficult appears to differ from depths associated with upward movement in spring. Comparisons of snow depths and moose abundance on higher ranges indicate that few moose inhabit these areas once snow depths reach 30 inches. Peterson (1955: 111) notes, however, that well over 30 inches of snow is necessary to restrict their movements in some types of snow.

From all these data there emerges a picture of winter range as a dynamic thing. The centre of distribution of moose moves downward through the winter. With snow depths increasing throughout the winter, and being greater at higher elevations, moose appear to be pushed downward by increasing snow depths. While other factors are involved, snow depths are one major factor inducing these migrations. The condition of snow, such as its density, may be important too, but this factor has not been adequately studied.

SUMMARY

Moose in the area studied undertake annual migrations between winter and summer ranges. Distance moved is 40 miles or more for some animals, while some may not migrate at all.

Spring migration upward begins suddenly and movement is at first rapid,

then slows. The start of this movement is associated with thaws and decreasing snow depths. Arrival of cold weather may slow the migration until warm weather returns.

Movement downward appears to be more leisurely, and continues through the winter as snow depths increase. This slow drift downward may continue until spring migration begins.

Winter range is a dynamic thing under these conditions, the centre of moose abundance moving downward slowly as snow accumulates throughout the winter.

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REPRODUCTION, SIZE, AND MORTALITY IN THE ROCKY MOUNTAIN MUSKRAT

BY HENRY M. REEVES AND ROGER M. WILLIAMS

Although the muskrat has received considerable investigative attention throughout the United States and Canada in recent years, few studies have dealt with the Rocky Mountain muskrat, *Ondatra zibethicus osoyoosensis* (Lord), the endemic subspecies of the Rocky Mountain and Puget Sound regions.

Two independent but similar studies at Gray's Lake and Dingle Swamp in southeastern Idaho afforded opportunity to obtain data on reproduction, sex and age ratios, subadult mortality, and size of the Rocky Mountain muskrat. A comparison of aging validity by external examination of reproductive organs (Baumgartner and Bellrose, 1943) and pelt primeness pattern (Applegate and Predmore, 1947; Shanks, 1948) with the internal examination of reproductive organs (Errington, 1939) was also undertaken on each area.

Field work at Gray's Lake was conducted by Williams from June, 1949, to May, 1950, while a graduate student at the University of Idaho and at Dingle Swamp by Reeves from April, 1952, to December, 1953, while employed by the Idaho Fish and Game Department as leader of Pittman-Robertson Project W 106-R.

The study areas.—Gray's Lake and Dingle Swamp remain two of Idaho's major muskrat producing marshes despite adverse environmental conditions created by irrigation water storage developments. Harvests of up to 50,000 pelts annually were formerly reported from each area, but recent harvests have seldom exceeded 10,000.

Gray's Lake, a 22,000 acre marsh, is located in a shallow, ancient lake basin at an altitude of 6,386 feet in Bonneville and Caribou Counties. Emergent aquatic vegetation covers an almost solid expanse of 19,800 acres and is chiefly hardstem bulrush (*Scirpus acutus*) with a minor interspersion of common cattail (*Typha latifolia*). Except for small scattered potholes and channels, the open water area is concentrated in the southeastern corner of the marsh. Prior to 1924, excess runoff flowed from the marsh through a natural outlet. However, in that year a drainage canal, cut below the former dead storage level, was opened and since then additional water has been withdrawn in varying amounts for irrigation purposes. Usual summer water depths range from one to two feet. During 1949 a maximum water level fluctuation of 3.1 feet was recorded between the early May spring peak and the September low. The locality typically has short, mild summers and long, rather severe winters. Mean temperatures of 18° F. for January and 63° F. for July and an average precipitation of 17.1 inches were recorded over a 25 year period. During the summer of 1949, temperatures were above normal but monthly rainfall was below average. Winter weather conditions in 1949–50 were near normal. Recent trapping seasons have generally consisted of a two week period in late April. Breeding population density during the summer of 1949, as determined by a count of active houses, was 0.4 muskrats per acre of habitat. A similar survey during the following winter indicated an average density of 1.6 animals per acre.

Dingle Swamp, a 16,000 acre remnant of an ancient lake basin, is located at an altitude of 5,920 feet in Bear Lake County, about 55 airline miles south of Gray's Lake. Predominate vegetation is also hardstem bulrush, but unlike Gray's Lake, several large lakes and waterways occupy much of the area so that the actual marsh emergents extend over only 8,929 acres. Water storage facilities permitting diversion of Bear River into the marsh were completed in 1917. Since then Dingle Swamp has served as a reservoir and settling basin, and water levels have been fluctuated erratically, often when the marsh was ice-covered. In 1952, water levels varied over a range of 3.5 feet, and in 1953, over 2 feet. The climate of Dingle Swamp is generally milder than that of Gray's Lake, but precipitation averages only 9.8 inches annually. Precipitation during the study was below average and temperatures during the 1952–53 winter were well below normal. Trapping seasons in recent years have been a short period in early April. Population surveys during the winters of 1952–53 and 1953–54 indicated average muskrat densities of 1.2 and 2.7 animals, respectively, per acre of habitat.

Supplemental data were obtained from muskrats trapped during open seasons on two other southeastern Idaho areas. A small sample of muskrats from the Bear River adjacent to Dingle Swamp was examined for sex ratio and size data.

Examination of a large series of pelts from other areas of Bear Lake County yielded additional sex ratio data.

Methods and techniques.—Muskrat houses were carefully opened during the spring and summer in a search for litters. Young were weighed, measured, sexed, and returned quickly to the nest. Only undisturbed litters found intact within houses were used in litter size calculations. To determine age and subsequently date of birth of young, measurements of nestlings at Gray's Lake were applied to Errington's growth curve (Errington, 1939) while a slight modification of Errington's curve was used at Dingle Swamp. Since the 30-day gestation period reported by other investigators (Errington, 1937; Smith, 1938) was found approximately correct, this figure was applied to date of birth to determine approximate date of conception. Nestlings were sexed by external appearance of genital organs and older animals were sexed by palpation to disclose differences between male and female genitalia (Dozier, 1942).

Carcasses of animals caught during the regular spring trapping seasons were examined for evidence of breeding. Production of young per female during the previous breeding season was determined by the number of placental scars per uterus found in a sample of fall-trapped muskrats (McCann, 1944; Sooter, 1946; Gashwiler, 1950). The total number of placental scars per uterus divided by the average number of young per litter was used to ascertain an approximation of number of litters born per breeding female. Only at Gray's Lake were placental scars per uterus separated into individual litters. Fall-trapped muskrats were sexed and aged by external examination of penis size, color, and ease of exposure, or presence or absence of vaginal membrane (Baumgartner and Bellrose, 1943). Dried pelts were sexed by presence or absence of mammae (Buss, 1941) and aged by pelt primeness pattern (Applegate and Predmore, 1947; Shanks, 1948). The accuracy of these methods was checked by internal examination of gonads (Errington, 1937). At Dingle Swamp, dentition characteristics and zygomatic breadth measurements (Alexander, 1951) served as an aid for aging some spring-trapped animals.

FINDINGS

Breeding and reproduction.—Over 350 muskrat carcasses from Gray's Lake were examined macroscopically during the spring trapping season, April 20 to 30, 1950, but none showed evidence of pregnancy. However, condition of the gonads indicated that all animals were in breeding condition and probably some females were pregnant, since between 10 and 14 days are required after fertilization for embryos to develop sufficiently to be readily visible (Gashwiler, 1950). Birth dates calculated for 69 litters in 1949 indicated that the young were born during an 80 day period from late May to mid-August at Gray's Lake, with a single peak occurring in early July. The 30 day gestation period thus indicates the first females were bred in late April and the last about mid-July.

Although more than 500 uteri were examined from animals trapped at Dingle Swamp during the 1952 and 1953 spring seasons, only one, caught April 7,

1953, contained easily discernible embryos. Gashwiler's data indicate this animal had mated prior to March 26. Parturition dates for 70 litters in 1953 showed that births occurred during a 100 day period from early May to late August, with a peak attained in late May. Muskrat reproduction activities began before and concluded after those at Gray's Lake, presumably because of differential climatic conditions.

Litter size.—Thirty-five complete litters from Gray's Lake examined in 1949 contained from 2 to 9 nestlings, with 6 being the most common; average litter size was 7.0 young. Individual litters identified in placental scar sets from fall-trapped females indicated an average litter size of 6.6 in 25 litters. Extremes were 2 and 11, with 8 the most frequently occurring size.

Thirty-one litters of Dingle Swamp muskrats in 1953 varied from 5 to 10 and averaged 7.3 young. Litters from Dingle Swamp one week or less in age averaged 8.0 young.

Average size of 66 complete litters examined during both studies was 7.1 young, with 7 being the most frequently encountered number.

Total number of young produced per female.—Of the 16 adult females trapped from Gray's Lake in the fall of 1949, one was a non-breeder. A total of 166 placental scars was found in 15 uteri, averaging 10.38 scars per female and 11.07 scars per breeding female. The number of scars per uterus ranged from 5 to 17. Eighteen of the 19 uteri from fall-trapped Dingle Swamp females in 1953 contained placental scars varying from 7 to 25 per uterus. Scars from these animals totalled 342, or an average of 18.00 per female and 19.00 per breeding female, almost twice the number found in Gray's Lake females in 1949.

During the 1953 spring trapping season on Dingle Swamp, an additional 390 uteri were scrutinized. Of these, only 19 contained distinct scars ranging from 3 to 17 per uterus and averaging 12.05. These are interpreted as minimum production figures for the previous summer because of probable fading of placental scar pigment. Since only 19 had placental scars an abnormally high subadult: adult ratio was indicated; thus, all 390 skulls were cleaned, zygomatic breadths measured, and dentition characteristics noted. The examination suggested that all 19 muskrats showing scars had passed through at least two breeding seasons and the remaining 371 were approaching their first or second breeding season. This presents the questions: (1) What effect does age have upon rate of placental scar pigment fading? (2) What effect does increasing age of breeding females have upon number of young produced per breeding season?

Number of litters per female.—By assuming that gestation extends for 30 days, and that females commonly re-mate shortly after giving birth to young, it would be theoretically possible for all Gray's Lake females to produce two litters per breeding season, and Dingle Swamp females, three litters. However, data indicated that this failed to occur regularly at either area. With the Gray's Lake data division of the average number of placental scars per breeding female (11.07) by the average litter size (7.0) suggested that breeding females averaged about 1.6 litters. Uterus scars from fall-trapped animals were also segregated into respective litters according to scar pigmentation opaqueness; 10 of the

females bore two litters, while 5 produced but one. The 25 litters produced by these 15 females indicate an average of 1.7 litters per breeding female.

At Dingle Swamp in 1953, the division of the average number of placental scars per breeding female (19.0) by average litter size of muskrats less than one week old (8.0) indicated an average birth of 2.4 litters per breeding female.

Barrenness.—Fall-trapped females known to be adult, but lacking placental scars, were designated as barren. Only one each of the respective 16 and 19 uteri examined at Gray's Lake and Dingle Swamp lacked placental scars, indicating that these animals were unproductive the previous summer. Although this sample is too small to measure the actual extent of non-breeding in the populations, it suggests that barrenness was not an important deterrent to reproductive success on either area.

Sex ratios.—Males consistently out-numbered females in all samples examined, regardless of location, age class, or time of year. Nestlings at Gray's Lake exhibited a sex ratio of 118 males: 100 females, based on 277 animals, while the ratio at Dingle Swamp was 123 males: 100 females for 356 animals.

Fall-trapped subadults at Gray's Lake and Dingle Swamp had ratios of 137 and 191 males: 100 females in samples of 140 and 157 muskrats, respectively. However, the Dingle Swamp figure may be biased since no attempt was made to thoroughly trap limited areas as was done at Gray's Lake.

All muskrats taken during the regular spring seasons were sexually mature and considered to be adults. Sex ratios ranged from 118 males: 100 females in 582 animals at Gray's Lake in 1949, to 178 males: 100 females for 1,593 animals trapped in Bear Lake County in 1953. Daily trapping records maintained at Dingle Swamp suggested a strong correlation between increase of males per female in the catch and ice breakup. Ice breakup in 1952 occurred on April 10 of the April 1 to 20 season. Based on 818 animals, males: 100 females shifted as follows: 100 (April 10), 102 (April 14), 113 (April 17), 146 (April 18), and 149 (April 20). Ice breakup in 1953 preceded the season's opening and a relatively high overall sex ratio of 137 males: 100 females was recorded for 929 muskrats examined. Small samples of fall-trapped adults had sex ratios of 125 males: 100 females and 106 males: 100 females for 36 and 35 animals at Gray's Lake and Dingle Swamp, respectively.

Overall sex ratio for 4,963 muskrats examined during both studies was 143 males: 100 females.

Age ratios.—Carcasses of fall-trapped muskrats were aged by internal appearance of reproductive organs. Of the 175 animals from Gray's Lake examined in 1949, an age ratio of 386 subadults: 100 adults was established. A slightly higher ratio of 403 subadults: 100 adults was determined for the 1953 sample of Dingle Swamp muskrats. These animals were also aged by external appearance of reproductive organs and by pelt primeness pattern. Only two of the 376 were erroneously aged using each of the latter methods, indicating that fall-trapped muskrats can be aged with a high degree of accuracy using either technique.

Subadult mortality.—Litters from Dingle Swamp when grouped by weekly

age classes decreased from 8.0 young per litter for those one week or less in age to 7.1 for those over two weeks of age. This represents a mortality of about 11 per cent during the first two weeks of life.

The ratio of subadults: 100 adult females at Gray's Lake in 1949 decreased from 1038 at time of litter birth (the average number of placental scars per female, 10.38 × 100) to 875 during the fall. Disregarding unknown adult mortality, this is a loss of 163 subadults: 100 adult females, or a mortality of 16 per cent from time of birth to time of trapping in late November and early December. Similar computations for Dingle Swamp animals in 1953 indicated a loss of 841 subadults: 100 adult females, or a 47 per cent mortality between time of birth and November trapping.

Size.—Total and body length for 20 newly born nestlings at Dingle Swamp for males averaged 83.5 mm. and 70.3 mm., respectively. Corresponding figures for females were 91.6 and 67.5 mm.

In both studies males out-weighed females. Spring-trapped males from Gray's Lake in 1950 averaged 909 gm., and females, 837. Dingle Swamp males averaged 843 gm., and females, 830, during the spring of 1953. Gray's Lake muskrats appear to be slightly heavier and larger than Dingle Swamp animals.

The muskrats of southeastern Idaho are among the smallest in the United States. Muskrats of this subspecies from Utah (Low, unpublished) weighed 1,039 gm. and 957 gm. for males and females, respectively. Average weights of other subspecies from California (Sooter, 1946), Maryland (Dozier, *et al.*, 1948), New York (Dozier, 1945), Pennsylvania (Grimm, 1941), Ohio (Anderson, 1947), Texas (Lay, 1945), and Wisconsin (Buss, 1941) are from 100 to over 650 gm. heavier than the largest muskrats examined during the present studies.

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SUMMARY

The Rocky Mountain muskrat, *Ondatra zibethicus osoyoosensis* (Lord), was studied on two large marshes, Gray's Lake and Dingle Swamp, in southeastern Idaho. Young muskrats were born from late May to mid-August at Gray's Lake and from early May to late August at Dingle Swamp. Thirty-five complete Gray's Lake litters ranged from 2 to 9 and averaged 7.0 young; 33 Dingle Swamp litters

varied from 5 to 10 and averaged 7.3 nestlings. Breeding females at Gray's Lake produced an average of 11 young, approximately 1.6 litters per season, and Dingle Swamp breeders, 19 young, with 2.4 litters per season. Barrenness in females appeared to be unimportant at both localities. A sex ratio of 143 males: 100 females was determined for 4,963 animals. A fall ratio of 386 subadults: 100 adults and 403 subadults: 100 adults was established at Gray's Lake and Dingle Swamp, respectively. The methods for aging by pelt primeness pattern and external examination of genitalia were found valid for fall-trapped muskrats. Subadult mortalities from time of birth to fall were calculated to be 16 and 47 per cent for Gray's Lake and Dingle Swamp. Muskrats of southeastern Idaho appear to be among the smallest in the United States.

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SKULL DIMENSIONS OF THE GREAT PLAINS MUSKRAT, *ONDATRA ZIBETHICUS CINNAMOMINUS*

By J. Henry Sather

The importance of cranial measurements is due primarily to their use by taxonomists to distinguish species and in some cases subspecies. The dangers of placing too great an emphasis on the taxonomic importance of cranial measurements were pointed out by Allen (1894). Tryon (1951) says that his studies indicate the need for careful evaluation and perhaps revaluation of the use of skull measurements at the subspecific level.

Hollister (1910) in his description of *Ondatra zibethicus cinnamominus* gives a few of the cranial measurements of the type specimen and the averages of measurements of five skulls of adults from the type locality. These measurements are repeated by Hollister in his "Systematic Synopsis of the Muskrats" (1911). Latimer and Riley (1934) reported on the cranial dimensions of 124 specimens of this subspecies collected in Kansas.

Insofar as can be determined, there are no published reports on skull dimensions of known-age animals for any of the muskrat subspecies.

All of the skulls reported on here were collected from lakes within the Valentine National Wildlife Refuge which is located in north central Nebraska. These skulls are of known age. The majority of them are from animals that were tagged during the summer months and harvested during the winter trapping period. Females that had borne more than one litter, as evidenced by placental scar counts, were undoubtedly adult females, and hence are included in the known-age adult female group. These skull dimensions are presented primarily to furnish information relative to the variation in skull measurements associated with differences in age and sex of this particular subspecies.

The dimensions were taken with a vernier caliper reading to one-tenth of a millimeter. Eight different dimensions of the skull were taken. The points of reference for taking these dimensions are as follows:

1. *Total skull length*—anterior surface of the incisors to the condylions.
2. *Condylo-alveolar length*—anterior margin of molar alveolus to condylion.
3. *Alveolar length*—anterior margin to posterior margin of upper molar alveolus: length of the molar tooth row.
4. *Cranial width*—least distance between outer surfaces of the small bars of the squamosal behind the zygomatic arch.
5. *Zygomatic width*—greatest distance between the outer surfaces of the zygomatic arches.
6. *Interorbital width*—least distance between the orbits.
7. *Length of diastema*—posterior margin of alveolus of incisor to anterior margin of molar alveolus.
8. *Basal length*—from the anteriormost inferior border of the foramen magnum to a line connecting the anteriormost part of the premaxilae (or anterior surface of incisors if more prominent).

The data on skull dimensions of adult males and females are presented in

TABLE 1.—*Skull dimensions of known-age adult males*

Dimensions	Sample size	Range	Mean	Standard deviation	Coefficient of variation, %
Total skull length	8	63.0–67.9	66.0–0.99	1.87	2.80
Zygomatic width	8	39.6–43.3	41.4–0.41	1.15	2.77
Interorbital width	8	5.6– 6.9	6.5–1.86	0.53	8.11
Cranial width	6	21.7–23.0	22.2–0.19	0.50	2.23
Diastema length	7	22.9–25.5	23.9–0.34	0.91	3.82
Basal length	7	60.9–64.6	62.8–0.59	1.58	2.51
Alveolar length	8	14.9–17.0	15.6–0.23	0.65	4.14
Condylo-alveolar length	8	36.3–40.3	38.3–0.04	1.22	3.18

TABLE 2.—*Skull dimensions of known-age adult females*

Dimensions	Sample size	Range	Mean	Standard deviation	Coefficient of variation, %
Total skull length	35	60.8–67.3	63.8–0.39	1.46	2.30
Zygomatic width	37	38.2–42.0	40.1–0.14	0.87	2.18
Interorbital width	37	5.0– 7.3	5.9–0.09	0.54	9.22
Cranial width	35	20.0–22.7	21.8–0.10	0.64	2.91
Diastema length	36	21.3–25.4	23.2–0.14	0.82	3.51
Basal length	34	58.3–64.1	60.9–0.25	1.44	2.36
Alveolar length	38	14.1–16.7	15.3–0.10	0.64	4.16
Condylo-alveolar length	35	35.7–39.5	37.2–0.14	0.84	2.27

Tables 1 and 2. Although it is impossible to distinguish sex by skull dimensions, it will be noted that insofar as means are concerned the males are larger in every dimension. There is very little difference between the two sexes in the coefficient of variation for each dimension. The most variable of the skull measurements is the interorbital width. The least variable measurement of the adult males is the cranial width and of the females, the zygomatic width.

Some of Hollister's (1910) mean dimensions of the type specimen of *Ondatra zibethicus cinnamominus* can be compared to those of this study. The basal length, zygomatic breadth, and alveolar length of the upper molar series of the type specimen skull are 55.9, 34.0, and 14.2 mm., respectively. It appears quite significant that only one of these dimensions is large enough to fall within the range of the same measurements of these known-age adults. Miss Schantz (in correspondence) advised that the type specimen is an adult according to the dentition method of aging.

Hollister (1910) also gives the following average measurements of five skulls of adults from the type locality: basal length, 56.3 mm.; zygomatic breadth, 35.5 mm.; alveolar length of upper molar series, 15.0 mm. Here again only one of the dimensions is large enough to fall within the range of the same measurements of the known-age adults from this study.

Latimer and Riley (1934) give skull dimensions of 124 specimens of this subspecies collected near Lawrence, Kansas. They considered the lack of epiphysial

TABLE 3.—*Combined skull dimensions of known-age adults and subadults*

Dimensions	Sample size	Range	Mean	Standard deviation	Coefficient of variation, %
Total skull length	96	54.8–67.9	62.6–0.25	2.43	3.88
Zygomatic width	92	34.4–43.3	38.9–0.18	1.79	4.60
Interorbital width	94	5.0– 7.3	6.2–0.05	0.48	7.71
Cranial width	91	20.0–23.0	21.8–0.06	0.57	2.61
Diastema length	94	20.5–25.5	22.7–0.15	1.44	5.02
Basal length	88	51.9–64.6	59.5–0.26	2.49	4.18
Alveolar length	96	13.6–17.0	15.1–0.06	0.63	4.16
Condylo-alveolar length	91	34.1–40.3	36.6–0.17	1.21	3.30

lines as evidence of maturity. They did not distinguish between the sexes, giving as their reason for this Hollister's (1911) statement that there are no sex differences in the measurements. As indicated earlier in this section, skull measurements of known-age adults show mean differences in favor of the males in every dimension. Gould and Kreeger (1948) also found a mean difference in favor of the males in every dimension except interorbital width.

Latimer and Riley gave the following mean dimensions and coefficients of variation for certain dimensions that can be compared to the data from this study: skull length, 62.4 mm. (3.92); alveolar length, 15.0 (4.16); diastema, 22.5 (5.68); skull breadth, 22.3 (2.75); zygomatic width, 38.3 (4.87). The mean dimensions of the known-age adults from this study are significantly greater than those of the Kansas sample. These differences could be regional, but there is a stronger indication that they are due primarily to a mixture of age groups in the Kansas material. One of the strongest points of evidence suggesting this is the higher coefficients of variation for skull length, diastema, and zygomatic width. It will be noted later that for most dimensions subadult skulls, especially the males, exhibit higher coefficients of variation than adult skulls. This higher variation in subadult animals is most probably due to the fact that several different growth stages are represented in the sample. It is interesting to note that when the subadult and adult skull dimensions of the muskrats in the present study are combined, the mean dimensions and the coefficients of variation are almost identical to those of the Kansas sample (Table 3).

The skull dimensions for known-age subadult males and females are presented in Tables 4 and 5. Here, as in the adults, there is a mean difference in favor of the males in every dimension. Quite striking is the fact that for most dimensions the coefficients of variation are significantly smaller in the females. Sex ratios that consistently favor the males among subadult animals may offer an explanation for this difference. Such sex ratios lead one to believe that more males from each age class have survived than females, and hence more variation in the skull dimensions of the males could be expected. Inasmuch as these differences in variation are not evident among adults animals, strength is added to this hypothesis.

The least variable dimensions among subadult females are the total skull

TABLE 4.—*Skull dimensions of known-age subadult males*

Dimensions	Sample size	Range	Mean	Standard deviation	Coefficient of variation, %
Total skull length	22	57.9–65.0	62.1–0.48	2.24	3.60
Zygomatic width	21	34.4–40.5	37.8–0.37	1.68	4.40
Interorbital width	22	5.8– 6.9	6.3–0.07	0.35	5.51
Cranial width	22	21.1–22.9	21.9–0.09	0.42	1.92
Diastema length	23	20.8–24.1	22.6–0.19	0.92	4.07
Basal length	21	54.3–61.6	58.9–0.42	1.95	3.31
Alveolar length	23	13.6–15.6	14.8–0.10	0.49	3.33
Condylo-alveolar length	21	34.3–38.1	36.4–0.02	1.01	2.77

TABLE 5.—*Skull dimensions of known-age subadult females*

Dimensions	Sample size	Range	Mean	Standard deviation	Coefficient of variation, %
Total skull length	15	58.7–61.8	60.4–0.25	0.98	1.62
Zygomatic width	14	35.5–38.7	37.0–0.23	0.98	1.62
Interorbital width	15	6.1– 6.6	6.3–0.05	0.21	3.33
Cranial width	17	20.3–22.4	21.6–0.14	0.56	2.60
Diastema length	17	20.5–23.6	21.8–0.18	0.75	3.44
Basal length	16	53.3–60.3	57.1–0.39	1.59	2.78
Alveolar length	15	14.1–16.4	14.7–0.14	0.54	3.67
Condylo-alveolar length	15	34.5–36.7	35.5–0.16	0.62	1.74

length and zygomatic width. Among subadult males the least variable measurements are cranial width and condylo-alveolar length.

The winter recovery of animals tagged as litter mates the preceding summer has furnished information relative to differences in skull dimensions of individuals of the same age.

Muskrats *191* and *140* were litter mates tagged during the summer of 1950. Muskrat *191* was harvested on December 12, 1950 and *140* on December 13, 1950, so there was one day difference in their ages. They were both males and approximately seven months of age. In the following cranial measurements, those of *191* are cited first: total skull length—62.7 and 62.3 mm., a difference of .4; condylo-alveolar length—36.0 and 36.8 mm., a difference of .8; cranial width—22.0 and 22.5 mm., a difference of .5; zygomatic width—38.3 mm. and no measurement for *140* due to the fact that one of the zygomatic arches was broken; interorbital width—5.9 and 5.9 mm., no difference; length of diastema—22.8 and 22.5 mm., a difference of .3; basal length—59.0 and 59.3 mm., a difference of .3.

Muskrats *660* and *661* were litter mates tagged during the summer of 1951. Both of these muskrats were males. They were harvested on the same day during the winter of 1951–52, and at that time they were approximately 227 days of age. The following cranial measurements were taken: total skull length—61.3 and 61.0 mm., a difference of .3; condylo-alveolar length—36.4 and 35.8 mm.,

a difference of .6; alveolar length—15.6 and 14.8 mm., a difference of .8; cranial width—22.3 and 22.0 mm., a difference of .3; zygomatic width—37.9 and 38.5 mm., a difference of .6; interorbital width—6.0 and 6.2 mm., a difference of .2; length of diastema—21.8 and 21.4 mm., a difference of .4; basal length—58.4 and 58.3 mm., a difference of .1.

This sample is small and probably more interesting than significant; however, it does indicate that litter mates as much as seven months of age exhibit very slight difference in skull dimensions. The greatest difference observed in the skull dimensions of these litter mates was .8 mm.

SUMMARY

The mean dimensions of both young and old muskrats are slightly larger for males than for females. The least variable dimension of adult males is the cranial width, and of adult females the zygomatic width. The least variable dimensions of subadult males are cranial width and condylo-alveolar length; whereas, the least variable dimensions of subadult females are the total skull length and zygomatic width. The greatest difference in skull dimensions of muskrats of the same age taken during their first winter was .8 mm.

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Department of Biological Sciences, Western Illinois State College, Macomb, Illinois. *Received January 20, 1956.*

CORRELATIONS BETWEEN REPRODUCTIVE CONDITION AND SKULL CHARACTERISTICS OF BEAVER

By Charles F. Bond

After fifty years of legal protection of the beaver (*Castor canadensis canadensis* Kuhl), annual midwinter trapping in Vermont was begun in 1950. At this same time, the Vermont Fish and Game Service began collecting carcasses from trappers for the purpose of analyzing the reproductive tracts and skulls, hoping principally to discover means of improving management of the beaver population in the State. Analysis of these carcasses was made in the Zoology Laboratory of the University of Vermont and the results are described here.

I thank Mr. Frank T. Haseltine, Project Leader of the Vermont Fish and Game Service, and all others of this group for their aid, including dissection of the carcasses. Helpful criticisms were made by Mr. Malcolm W. Coulter, Maine Cooperative Wildlife Research Unit, Professors Paul A. Moody and Lyman S. Rowell, University of Vermont, and Professors Samuel L. Leonard and Perry W. Gilbert, Cornell University. I am grateful to those who assisted in making the measurements and to my wife, Amy, who prepared the figures and aided in the statistical analysis of the data. Financial support was provided by Project W-9-R of the Federal Fish and Wildlife Service and administered by Roger A. Seamans, Federal Aid Coordinator.

Materials and methods.—The reproductive tracts were preserved in ten per cent formalin solution. Testes and epididymides used in the study of incidence of spermatogenesis were embedded in paraffin, sectioned at eight to ten micra, mounted, and examined under oil immersion magnification (950×). An animal was recorded as showing spermatogenic activity only when spermatozoa were observed in the epididymis as well as the testis. The total length and the height at the base of each baculum were recorded.

Both ovaries of each female were hand-sectioned (sections about one millimeter thick) under a stereoscopic dissecting microscope (15.3×), and counts of corpora lutea and corpora albicantes were made. Embryos were located in the uteri by macroscopic examination, and the crown-rump length of each was measured.

Skull dimensions measured with the aid of dividers and a meter stick were: (1) total length, (2) frontal width, (3) lambdoidal ridge length (obtained by adding the distance from one end of the ridge to the midline and the corresponding distance on the opposite side), (4) length of the parietal bone, (5) zygomatic breadth, (6) diastema length, and (7) sagittal crest length (here defined as the distance from the intersection of the crest with the lambdoidal ridge forward to its intersection with the temporal lines). All dimensions are straight-line distances between the points of measurement. In addition, the condition of the occipital sutures of each skull was observed and recorded.

RESULTS AND DISCUSSION

Sex ratios.—In the 2164 beaver carcasses examined this ratio was 108 males per 100 females, identical with that reported by Bradt (1938). However, since others (Grinnell

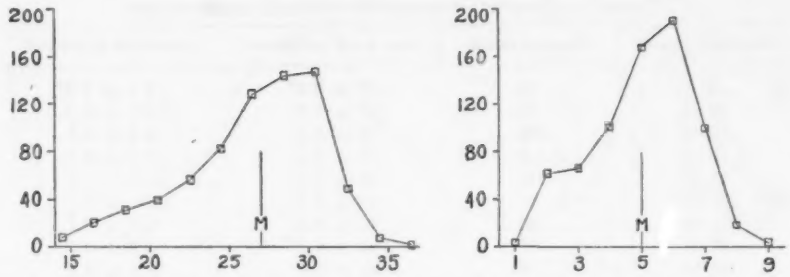

FIG. 1.—Frequency distributions of dimensions of bacula. LEFT: length of bone in millimeters plotted against number of bacula. RIGHT: height at base in millimeters plotted against number. Mean values are indicated by the lines labeled M.

et al, 1937; Osborn, 1953) had found fewer males than females among older animals, the relationship between sex and carcass weight was examined and the observations of the previous investigators were confirmed by the results. In 702 animals 21 to 30 pounds in carcass weight the ratio was 120/100, while in 354 heavier beaver it had decreased to 84/100. Although battles among males in the mating season may contribute to increased mortality in this sex (Grinnell *et al*, 1937), the presence of genetic or other factors affecting normal life expectancies have not been eliminated.

Bacula and spermatogenesis.—Frequency distributions of the measurements of baculum length and height are shown in Figure 1, while in Table 1 the relation between baculum size and carcass weight is presented. Since it was desired to correlate baculum size with the onset of spermatogenic activity, the testes and epididymides of a representative sample of males were examined histologically. The findings are summarized in Table 2. It is evident that spermatogenesis does not begin in all males at the same time; however, most males appear sexually mature, on the basis of production of spermatozoa, when the baculum has attained a size of 24 mm. x 3.9 mm. Carcasses of these males weigh from 15 to 19 pounds (Table 1).

Ovaries, embryos, and breeding season.—Any interpretation of observations of female reproductive tracts must include the factor of the estrous cycle. Since all females studied were trapped in February, the condition of the tracts should have been representative of the breeding state (Bradt, 1939; Asdell, 1946).

The incidence of corpora lutea in the ovaries is summarized in Table 3. However, under the conditions employed in this study, embryos were located in the uteri of 58 animals only. All embryos were small, with crown-rump lengths under 25 mm. (two exceptions). It is believed that one reason for the striking difference between the number of females with corpora lutea and the number with embryos is that many animals were trapped so early in the gestation period that the embryos had not yet attained a size sufficient to permit detection. As a second reason it is suggested that some corpora lutea were those of ovulation rather than pregnancy. Corner (1917) noted the difficulty of distinguishing the various stages of this ovarian structure in the pig, the differences being largely quantitative. Should this be true in the beaver, the occurrence of a corpus luteum can signify, in this study, only that ovulation had taken place. It is of interest that none of the 58 females with embryos weighed under 24 pounds, yet 67 of the 512 animals lighter than this figure possessed corpora lutea. Perhaps a significant proportion of this group were unmated young females.

In a survey of the literature, Asdell (1946) reported a mean embryo count of 3.68 ± 0.12 per female. In the present study there were 4.1 embryos per female and 1.16 corpora lutea per embryo. This again may be considered representative of conditions early in gestation, and a comparison with data reported by Osborn (1953) is instructive. In the 22 females in

TABLE 1.—*Baculum dimensions in relation to carcass weights*

Weight class (pounds)	Number of animals	Mean length (millimeters)	Mean height (millimeters)
5– 9	12	17 ± 0.6*	2.1 ± 0.2*
10–14	78	19 ± 0.5	3.1 ± 0.2
15–19	106	24 ± 0.3	3.9 ± 0.1
20–24	136	27 ± 0.2	5.0 ± 0.1
25–29	155	29 ± 0.2	5.8 ± 0.1
30–34	97	30 ± 0.2	6.3 ± 0.1
35–39	43	30 ± 0.3	6.2 ± 0.1
40–44	17	31 ± 0.4	6.2 ± 0.2
45–49	4	33 ± 0.9	7.2 ± 0.3

* Standard error

TABLE 2.—*Incidence of spermatogenesis in relation to baculum dimensions*

Baculum length (millimeters)	Number of animals examined	Per cent showing spermatogenesis	Baculum height (millimeters)	Number of animals examined	Per cent showing spermatogenesis
16–17	4	0	1	1	0
18–19	11	0	2	13	8
20–21	11	36	3	30	43
22–23	22	54	4	29	72
24–25	32	81	5	38	92
26–27	24	83	over 5	44	89
over 27	46	93			

TABLE 3.—*Incidence of corpora lutea*

Weight class (pounds)	Number of animals	Number with corpora lutea in ovaries	Per cent
10–14	194	2	1.0
15–19	158	14	8.9
20–24	160	51	31.4
25–29	148	83	56.1
30–34	131	98	74.8
35–39	64	47	73.4
40–44	25	23	92.0
45–49	8	5	62.5

his data there were only 2.91 fetuses per animal, and the smallest fetus (123 mm. in total length) was larger than the embryos of this study, including the two exceptions (crown-rump length of the larger was 80 mm.). Osborn reported that there had been over 27 per cent resorption of embryos. It is not likely that resorption of such magnitude had occurred in the Vermont animals inasmuch as the ratio of corpora lutea to embryos was nearly one to one, the expected value if each follicle in which ovulation has occurred becomes luteinized.

When a corpus luteum degenerates, it becomes transformed into a mass of scar tissue known as a corpus albicans. The presence of corpora albicantes in ovaries during the breeding season indicates either (1) that copora lutea of ovulation have already degenerated or (2) that traces of scar tissue of the previous season remain. In the latter case the corpora lutea were probably those of pregnancy. Whichever type any particular corpus albicans

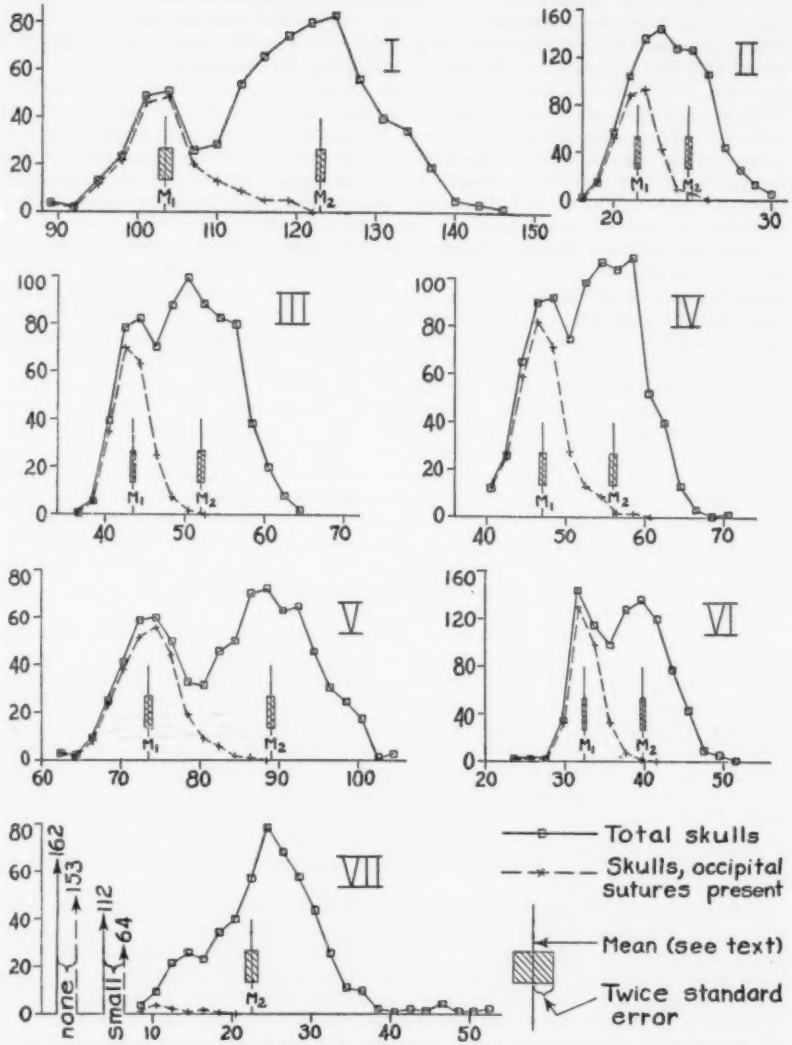

FIG. 2.—Frequency distributions of skull dimensions and occurrence of occipital sutures. All dimensions are given in millimeters and are plotted against number of skulls. I—Total length; II—Frontal width; III—Lambdoidal ridge; IV—Parietal length; V—Zygomatic breadth; VI—Diastema length; VII—Sagittal crest length; in this dimension measurements between 0 and 8 mm. were difficult to make and were recorded as "small". In computing the mean and standard error, an arbitrary value was assigned to these measurements.

may be, the change in incidence of these ovarian scars in the females trapped during the first three open seasons in Vermont is of interest. In the first year 41.2 per cent of the 315 females possessed corpora albicantes; in the next two years they were found in only 28.5 and 27.4 per cent of the 436 and 296 females respectively. No data are available for succeeding years. It is suggested that this drop in the incidence of scars resulted from a decrease in the remains of corpora lutea of previous pregnancies as a result of the effect on mated pairs of trapping during the breeding season. This probably would occur when the male of a pair was trapped just prior to copulation, for it is unlikely that the female would find a new partner during that season. Hence, if she were trapped the following year, the scars of corpora lutea of ovulation of the previous year probably would not have persisted in a condition that would permit detection by the methods of this study.

Skull dimensions.—Frequency distributions of the measurements, as well as of the incidences of occipital sutures, are presented in Figure 2. Since no sex dimorphism was discovered, the distributions shown are those of males and females combined. For each dimension two means were calculated: M_1—the mean of the skulls with occipital sutures present, and M_2—the mean of the remaining skulls. In each distribution M_1 is significantly smaller than M_2. Furthermore, where a distribution is bimodal, the left peak is composed primarily of skulls in which these sutures are still present. Of particular interest is the fact that the sagittal crest begins to appear as the sutures disappear. In addition, it may be noted here that loss of the deciduous molar teeth in both sexes occurs at this stage. Information on the condition of these teeth was obtained by Mr. Arthur Cook of the New York State Conservation Department through examination of a large sample of the skulls with a fluoroscope. Thus, the frequency distribution plots suggest that there may be recognized (1) a group of immature animals in which the skull dimensions are those of the animals with occipital sutures and deciduous molars present, (2) a group of mature animals in which these sutures and teeth have disappeared, and (3) a group in transition from immaturity to maturity in which the skull dimensions are those of animals occupying the low region between the peaks in each frequency distribution.

Interrelationships.—Since zygomatic breadth is readily measured in the field, requiring a minimum of dissection to expose the zygomata and no elaborate preservation of tissues, it was decided to relate other dimensions, including the length of the baculum, to it. Therefore, coefficients of correlation were calculated between zygomatic breadth and each of the following: (1) total length, (2) diastema length, (3) sagittal crest length, and (4) baculum length. These coefficients are given in Table 4 along with equations for the lines of regression of these skull dimensions on zygomatic breadth. Each line of regression is based on the value of the corresponding correlation coefficient and is a measure of the most probable value of the dimension (Y) for any value of zygomatic breadth (X). The lack of any sex dimorphism in frequency distributions of skull dimensions (see above) is emphasized by the fact that correlation of skull dimensions with zygomatic breadth likewise revealed no differences in the two sexes.

The lowest point between the peaks of the zygomatic breadth distribution curve (Fig. 2, V) has an approximate value of 80 mm. Substitution of this value in the equations given in Table 4 yielded the results shown in Table 5. Since the calculated baculum length was found to be the same as the mean length of this bone in 15 to 19 pound males, the calculated skull dimensions were also compared with those of this group of males (Table 5). The agreement between calculated and observed values is striking in every instance with the exception of sagittal crest length. However, the discrepancy here is not significant since the mean value of this crest in the 65 males in the 20 to 24 pound group is 18 ± 1.1 mm.

A second striking feature of the values of the skull dimensions in Table 5 is that each falls in the region between the peaks of the appropriate curve in Figure 2. It has already been suggested that, on the basis of conditions of the skull, the animals represented here constituted a group in transition from immaturity to maturity. These same animals, on the basis of incidence of spermatogenic activity, could be considered newly mature. It is inter-

TABLE 4.—*Correlation coefficients (R_{xy}) and lines of regression on zygomatic breadth (X) of certain skull dimensions and baculum length*

Dimension (Y)	Correlation coefficient (R_{xy})	Number of animals	Line of regression (Y in terms of X)
Total length	0.89	691*	Y = 1.23 X + 12.6
Diastema length	0.91	817*	Y = 0.45 X − 0.6
Sagittal crest length**	0.70	722*	Y = 0.92 X − 60.7
Baculum length	0.72	197	Y = 0.373 X − 5.67

* Males and females

** For purposes of analysis, arbitrary values assigned to crests recorded as small

TABLE 5.—*Comparison between (1) values of skull dimensions and baculum length calculated using equations of lines of regression on zygomatic breadth (Table 4) when X = 80.0 mm. and (2) observed values in males 15 to 19 pounds in carcass weight*

Dimension	Value calculated using equation in Table 4 (millimeters)	Mean value in 15 to 19 pound males (millimeters)	Number of 15 to 19 pound males
Zygomatic breadth	80.0*	79 ± 0.7**	52
Total length	110.9	111 ± 1.2	40
Diastema length	35.4	35 ± 0.5	52
Sagittal crest length	12.9	8 ± 1.2	56
Baculum length	24.1	24 ± 0.3	106

* Value substituted for X in equations in Table 4

** Standard error

esting to note here that in the 15 to 19 pound females no embryos were located in the uteri and corpora lutea were observed in the ovaries of only 8.9 per cent of this group.

Zygomatic breadth values reported in the literature have also been related to state of maturity. Friley (1949) found that yearling beaver trapped in early spring in Michigan had a mean breadth of 79.7 mm., while that of two- and three-year olds was 92.1 mm. Osborn (1953) established three age classes (yearling, subadult or two-year old, and adult) for beaver trapped in Wyoming between April and November in which the 23 yearlings had a mean breadth of 77.49 ± 0.75 mm. and the 19 subadults a breadth of 87.32 ± 0.66 mm. In this study of beaver trapped in Vermont in February, the immature group (occipital sutures present) had a mean zygomatic breadth of 73.6 ± 0.2 mm. (Fig. 2, V, M_1). The mean breadth of all other animals was 88.8 ± 0.3 mm. (Fig. 2, V, M_2).

Thus it is seen that coefficients of correlation and equations of lines of regression may be employed to predict the most probable constitution of any animal in which the value of a single dimension is known. This suggests that considerable information concerning the nature of and changes in the beaver population of a relatively large area may be obtained by plotting the frequency distribution of zygomatic breadth of the annual kill.

SUMMARY

Reproductive tracts and skulls of a large number of beaver trapped in Vermont were examined. The sex ratio of 2164 animals was 108 males per 100 females, but in animals over 30 pounds in carcass weight it was only 84 males per 100 females.

The onset of spermatogenic activity in males was correlated with baculum

size. It was found that males that had just attained sexual maturity possessed bacula measuring 24 mm. (mean length) by 3.9 mm. (mean height). These males belonged in the 15 to 19 pound carcass weight group.

Examination of the female reproductive tracts revealed that trapping had occurred early in the breeding season; embryos were few and small, but corpora lutea were numerous. No embryos were found in females under 24 pounds in carcass weight. It is believed that the discrepancy between the number of corpora lutea and the number of observed embryos may be accounted for, in part, by assuming (1) that many embryos were too small to be detected by the method used and (2) that the corpora lutea in a number of females indicated only that ovulation had occurred. The incidence of corpora albicantes in females taken in the first year of trapping was 41.2 per cent, compared with 28.5 and 27.4 per cent in the next two years. This decrease, it is believed, resulted from trapping the males of mated pairs just prior to copulation. Thus, in the following year, the females of these pairs probably had no corpora albicantes.

Skull dimensions were measured and correlation coefficients and lines of regression were calculated, all based on zygomatic breadth, the dimension considered most easily measured in the field. No sex dimorphism in skulls was discovered. The correlation coefficient for baculum length with zygomatic breadth was 0.72. Excellent agreement was obtained in the comparisons between calculated and observed values of skull dimensions and baculum length of males in transition from immaturity to maturity. This indicates that the most probable condition of the skull and reproductive tract of an animal may be predicted when the zygomatic breadth is known. The use of the frequency distribution plot of zygomatic breadth as a means of keeping track of changes in the composition of a large population is suggested.

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A COMPARISON OF NATALITY RATES IN WHITE-FOOTED MICE FOR FOUR YEARS

By David E. Davis

Data on reproductive rate that permit comparison of several years are scarce. For this reason some data are presented here that describe the population and reproduction of *Peromyscus leucopus* in a woods in New Jersey. Even the extensive literature on *Peromyscus* provides few opportunities to examine changes in breeding during different years. One study (Jameson, Jour. Mamm., 34: 44–58, 1953) discusses the breeding condition of *Peromyscus maniculatus* and *P. boylii*. He compares the percentages pregnant in various months but not in various years. However, he did give data for the fecundity (breeding condition) in three years but these data do not indicate the reproductive rate.

The mice here described were collected at Seabrook, N. J., in the area described by Davis, *et al.* (Trans. N. Amer. Wildlife Conf., 16: 283–289, 1951) who discussed the effect of disposal of sewage effluent on mice. None of the data recorded here were collected in spots that were directly sprayed with effluent. Jackson (Ecol. Mono., 22: 259–281, 1952) described the characteristics of mice in the region in detail from data collected in 1951 and 1952 in nearby areas.

To describe the vegetation of the area, the composition of the trees was determined in quadrats 100 x 100 feet. All trees more than 4.5 feet high were measured. By means of these quadrats an area primarily of oaks was delimited and used for this work. The trees in the 91 quadrats in this area are given in Table 1 which gives relative density (per cent of trees belonging to each species),

Table 1.—*Composition of trees in 91 quadrats of forest*

Species	Trees	Relative density	Basal area	Relative basal area	Quadrats	Frequency	Relative frequency
Quercus alba	645	41.7	8379	39.2	85	93.6	23.5
Quercus rubra	121	7.8	2632	12.3	30	33.0	8.3
Quercus velutina	260	16.8	6537	30.6	74	81.5	20.4
Quercus marilandia	47	3.0	564	2.6	11	12.1	3.0
Quercus falcata	12	0.8	301	1.4	8	8.9	2.4
Quercus prinus	12	0.8	363	1.7	3	3.3	0.8
Quercus palustris	65	4.2	918	4.3	11	12.1	3.0
Quercus stellata	7	0.5	69	0.3	6	6.6	1.5
Carya tomentosa	87	5.6	598	2.7	39	42.9	10.8
Carya glabra	9	1.6	61	0.3	6	6.6	1.5
Prunus spp.	7	0.5	112	0.5	6	6.6	1.5
Sassafrass variifolium	41	2.6	148	0.7	18	19.7	4.5
Cornus florida	192	12.4	502	2.3	38	41.8	10.5
Ilex opaca	20	1.3	50	0.2	15	16.5	4.2
Chamaecyparis thyoides	5	0.3	28	0.1	4	4.4	1.2
Pinus spp.	3	0.2	15	0.1	2	2.2	0.6
Acer rubrum	14	0.9	69	0.3	4	4.4	1.2
Nyssa sylvatica	1	0.1	19	0.1	1	1.1	0.3
Totals	1548	101.1	21,365	99.7	91	397.3	99.2

relative basal area (per cent of basal area for each species), frequency (per cent of quadrats having each species) and relative frequency (per cent of frequency for each species). The predominance of oaks is apparent.

For this work the mice were collected in snap traps set at 25 foot intervals (one trap per station) along straight, parallel lines that were 250 feet apart. The traps were set in the afternoon, checked and reset the next morning and then checked and picked up the second day. The lines were not all trapped simultaneously but all lines were trapped within 2 weeks. The mice and other animals were examined in the laboratory in the afternoon.

The population size may be considered from the numbers of mice caught per trap night. Comparison of these figures assumes that weather has a trivial effect and that the traps do not compete with each other for mice. The first assumption is likely to be true for Jackson (1952) found no evidence that weather affected trap success. The second assumption is probably true since so many traps were set in the area that a trap should always be available to a mouse. If we assume a home range at least 100 feet in diameter (Stickel, Jour. Wildlife Mgt., 12: 153–161, 1948) then the mouse had up to eight chances to be caught (4 traps for 2 nights). To account for traps that were sprung, or caught another species, 0.5 trap night was subtracted from the total for each trap sprung. Table 2 presents the results of trapping in the four years. None of the differences in mice per 100 trap nights is significant and it is concluded that there is no evidence that the population changed.

The pregnancy rates for the four years are given for comparison in Table 3. Mature females are defined as those having the vaginal orifice perforated. The proportions pregnant in the years 1950, 1951 and 1952 are indistinguishable, but in 1953 the proportion was significantly lower than in 1950 or in 1951 ($P < 0.01$). The low pregnancy in 1953 is not due to a high number of small mice in the sample. Indeed, in 1953, 79 per cent of the mice were over 90

TABLE 2.—*Frequency of capture of Peromyscus*

Year	Dates	Trap nights	Mice per 100 trap nights
1950	Sept. 24–Oct. 8	1694.0	6.02
1951	Sept. 22–Sept. 28	2457.0	4.97
1952	Sept. 20–Sept. 24	2443.5	6.63
1953	Sept. 17–Sept. 21	2973.5	5.23

TABLE 3.—*Percentages pregnant and litter size of mature females*

Year	Mature females	Per cent pregnant	Litter size	Standard deviation
1950	44	55	4.42	1.16
1951	68	55	4.62	1.05
1952	69	46	4.87	0.87
1953	72	33	4.40	1.22
	—	..	....	....
Total	253	46	4.59	0.98

TABLE 4.—*Length at which 50 per cent of the mice reached sexual maturity*

Year	Males	Scrotal, mm.	Standard error	Females	Perforate, mm.	Standard error
1950	64	83	1.17	51	83	4.62
1951	81	79	1.91	80	80	1.16
1952	109	85	1.04	82	74	2.23
1953	126	82	1.47	96	88	1.57
Total	380	82	—	309	82	—

TABLE 5.—*Relation of percentage pregnant and litter size to length*

Length in mm.	Total females	Per cent pregnant	Mature females	Per cent pregnant	Litters	Mean	Standard deviation
60–89	115	25.2	68	42.7	29	4.10	0.9
90–109	194	45.4	185	47.6	88	4.72	1.0
Total	309	37.8	253	46.3	117	4.59	0.8

mm. in length whereas in 1951 only 66 per cent, and in 1952 only 68 per cent, were over 90 mm. There is no significant difference in litter size between any of the years or among the years.

The size at sexual maturity might influence the reproductive rate because in one year the females might become sexually mature at an early age (size). Then there would be a higher number of births even though the proportion pregnant was the same because a higher proportion of females would be mature. Table 4 gives the length in the four years at which 50 per cent of the mice became sexually "mature," where mature is defined as having testes descended into the cremaster sac ("scrotum") or the vaginal orifice perforated. These points can be compared to indicate differences from year to year in the age at sexual maturity. In no case was a pregnant mouse found with the vaginal orifice closed as reported for two other species of the genus by Jameson (1953). It is, of course, true that mice in different years might grow at different rates and thus have different 50 per cent points represent the same age. However, since mice that grow rapidly tend to mature early, this factor operates in the opposite direction. Thus mice with the same 50 per cent points may have different ages. The analysis of Table 4 shows that male mice matured earlier in 1951 than in 1952 and that females matured earlier in 1952 than in 1951 or 1953.

It is noteworthy that smaller (younger) females have smaller litters and lower pregnancy rate (Table 5).

From the evidence available it would appear that some considerable changes in reproductive rate may have occurred. Compare, for example, 1951 and 1953. In 1951 a higher proportion of mature mice became pregnant, and the mice reached maturity at a smaller size (the number of embryos was greater but not significantly so). Thus in 1951 out of 100 females perhaps 80 were mature and 44 pregnant and producing 44 (4.6) = 202 embryos whereas in 1953 out of 100

females perhaps 70 were mature and 23 pregnant and producing 23 (4.4) = 101 embryos.

It should be noted that the various measures of reproduction do not in any one year all operate in the same direction. Thus there is a considerable stability in the number of young produced from year to year. Since a variety of mortality factors operate on the young mice during the summer it is no surprise that the September populations are essentially constant.

Summary.—White-footed mice (*Peromyscus leucopus*) were captured in snap traps in late September from 1950–1953, inclusive, in an oak woods in southern New Jersey. Based on the number of mice caught per trap night there was no detectable change in the population. The proportion pregnant varied from 33 to 55 and the litter size varied from 4.40 to 4.87. The size at maturity (as defined) differed in the various years. Small mice had lower reproductive rates than did large mice. It is concluded that in spite of some changes in reproductive rates the population remained essentially unchanged in numbers.

Johns Hopkins School of Hygiene and Public Health, Baltimore, Maryland. Received January 18, 1956.

JUVENILE MOLT IN *PEROMYSCUS LEUCOPUS NOVEBORACENSIS*

By Jack L. Gottschang

A survey of the literature indicates that previous workers (Osgood, 1909; Nicholson, 1941; Hamilton, 1943; Cahalane, 1947; Burt, 1949) have been aware of the change from the gray juvenile pelage to the "rufous" or cinnamon red of the adult deer mouse, *Peromyscus leucopus noveboracensis*, but no investigation has been made of the progress of the pelage change or the factors that control it. Collins (1918), studied pelage change in *Peromyscus maniculatus gambeli* and several other closely related western forms. The present study was initiated with a two-fold purpose; (1) to follow the course of the pelage change; (2) to correlate age with pelage change. The data presented here are from observations made on deer mice captured in the Ithaca, New York, region during the summers of 1949 and 1950 and from animals of the same subspecies taken in the Cincinnati, Ohio, area during the spring and summer of 1954. All observations were made on litters born and raised in captivity. All litters were from pregnant females captured in the field. No attempt was made to breed the mice in captivity. In order that environmental conditions might be as natural as possible, the animals were kept in large outdoor cages placed directly on the ground. Each cage, constructed of ¼ inch hardware wire, was three feet long and one foot square in cross section, and equipped with a large one-foot-square wooden nesting box. Tall grass and weeds soon grew up through the wire mesh and provided excellent cover for the animals. Since these mice are extremely nervous, they were observed and handled as infrequently as possible. Before the onset of pelage change the animals were never handled, although daily observations of the nest were made. When checking the pelage, the mice were caught and examined on an average of about every

fourth day. Occasionally the animals were checked twice daily. Sufficient and varied food was provided to keep them in good physical condition. Individuals were identified by clipping the toes as suggested by Burt (1940).

The terms used here for describing the colors of the pelage were determined by comparing the living specimens with the color charts of Ridgeway (1912).

The molt from the deep mouse-gray juvenile pelage to the cinnamon-rufous pelage, although varying in small details appears to follow a very definite pattern. The new fur appears first as a small patch or as a narrow line just above and in front of the hind leg. Either this new patch of fur appears very suddenly or is difficult to detect at the onset, for on several occasions mice that had been examined in the morning and had shown no sign of a pelage change, had the new patch of fur present the same evening. The molt then progresses forward. Usually before the "rufous" stripe has reached the front legs a small patch of

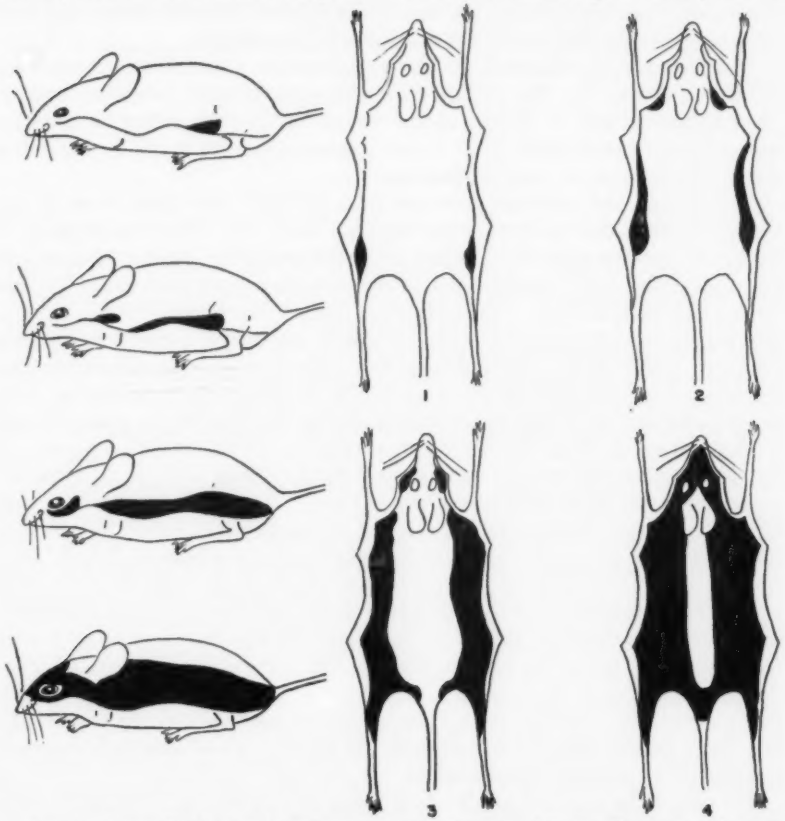

FIG. 1.—LEFT: Typical molt pattern, as seen from the side, for *Peromyscus leucopus noveboracensis* when changing from the gray juvenile pelage to the cinnamon-rufous of the adult. Shaded areas represent the cinnamon-rufous pelage. RIGHT: Typical molt pattern, as seen from above.

new fur appears on the shoulders of the mouse. The two separate patches then enlarge until they meet and form a continuous line along the side separating the white of the belly from the dark mouse-gray on the rest of the back. The width of this line varies from ⅛ to ¼ inch; it may be wide posteriorly and narrow anteriorly or the reverse may be true. While this line along either side is increasing in width a cinnamon-rufous patch appears on each cheek just below the eye. This enlarges until it replaces all the gray on the sides of the face. Meanwhile the rufous line along the sides of the body has extended from the hind leg back to the base of the tail. The broad gray stripe down the center of the back is then slowly replaced by the cinnamon-rufous fur of the adult. The last gray to be replaced is either that at the very base of the tail or that across the top of the shoulders and on top of the head between the ears. These two patches may disappear simultaneously (Fig. 1). The pattern is the same for males and females. Observations on many mice captured in the field in both the Ithaca and Cincinnati areas substantiate the data obtained from captives.

Nicholson (1941), who studied *Peromyscus leucopus noveboracensis* in southern Michigan, states: ". . . the young retain their gray juvenile pelage until about 40 or 45 days of age; at 45 days of age the buff of the adult pelage becomes apparent in the dorsal stripe; . . .". In the present study the "buff" in the dorsal stripe was the last to become apparent.

About three and one-half weeks are required after the onset of the pelage change for most deer mice to attain their full adult coat. The shortest time recorded for captive mice was 12 days while the maximum number of days was about 36 (Table 1). A young male deer mouse captured and observed in the field on June 23, 1950 showed no signs of pelage change. When next taken on July 3, this animal had completed his molt. This is an instance of a mouse completing the entire molt within a period of ten days (Table 2) and is a shorter period than recorded for any of the captive specimens. The 53-day period indicated for male No. 4 in Table 2 is not exactly the length of time required for the pelage change of this mouse. On June 23, when first taken, the animal was mouse-gray; on August 16 the entire pelage was cinnamon-rufous. There were no captures between these two dates. However, there is some indication in both captive and wild mice that some few individuals extend the molt over an indefinite period of time. A litter of five mice, four males and one female, was born on July 1, 1954. All five started the pelage change on August 16, at an age of 45 days. On September 28, 43 days after the onset of pelage change, the female had not completed the change, although all four of her brothers had attained their adult rufous coats within 35 days. The molt pattern for this female was atypical. On September 28, the only gray remaining on the mouse was a small saddle-shaped patch across the shoulders and a smaller rounded patch above the base of the tail. Early on the morning of September 29 all the mice of this litter escaped, making further observation impossible.

The age at the onset of pelage change varies considerably in different mice. The youngest animals to start the molt were 38 days old. These were all males and, with one exception, were all in the same litter. One female was 60 days old before starting to molt. Ninety-five per cent of the mice of both sexes started the

TABLE 1.—*Age at the onset of pelage change and approximate number of days necessary to complete the molt from the gray juvenile pelage to the cinnamon-rufous of the adult. Data from seven captive mice*

Sex	Age at onset	Age at completion	Total no. of days
♂	38 days	67 days	29
♂	38 days	57 days	19
♀	48 days	69 days	21
♀	40 days	57 days	17
♀	45 days	73 days	28
♂	38 days	57 days	19
♂	39 days	53 days	12

TABLE 2.—*Pelage data from five Peromyscus leucopus noveboracensis live-trapped in the field. Mice on the first date of capture had gray coats; on the last date of capture cinnamon-rufous coats*

Sex	First date of capture	Last date of capture	Total no. of days
♀	May 23	June 26	34
♂	June 8	July 1	22
♂	June 23	July 3	10
♀	May 22	June 8	17
♂ (no. 4)	June 23	Aug. 16	53

pelage change between the ages of 40 and 50 days. Collins (*op. cit.*), reports: "Transition from juvenile to postjuvenile pelage usually begins at the age of six weeks and is completed about eight weeks later."

As a general rule, mice of the same sex in a single litter started molting simultaneously. In many instances animals of both sexes started to molt at the same time. However, there was sometimes as much as ten days' difference between males and females. In every case where a difference did occur it was the males that started to molt first.

The factors affecting the pelage change are not apparent. The author first suspected that the larger littermates would molt first. However, in at least one litter, it was the smallest individual that first commenced to molt. Since this study was primarily concerned with obtaining information that could be readily applied in the field, weights of individual juvenile mice observed in New York were not recorded. It was later realized that this might be important, for it was quite possible that weight and onset of pelage change are closely linked. Consequently, in the 1954 study the weight of each individual was recorded on the day the pelage change started. It was soon apparent that the weight of individual mice had no direct relationship to the onset of pelage change. Male weights were: 9.5, 9.7, 10.6, 8.8, 13.5, 14.0, 14.0, 13.3, 13.0, 11.6, ave. 11.8. Female weights were: 9.0, 10.0, 10.7, 12.3, 13.5, 10.6, 11.6, ave. 11.1. Not only were the weights of the different mice in various litters highly variable at the onset of the molt, but there was great variation among members of the same litter. In one instance the smallest member of a litter, a male weighing 8.8 grams, started to molt on the same day as his largest littermate, a female weighing 12.3 grams.

Weather conditions probably have little or no effect on pelage change. No difference in the onset, progress or length of time required for the pelage change was noted between spring, summer, or fall-born litters.

The weight of 64 deer mice from the Ithaca, New York area indicates an average of 19.8 grams for adult individuals. Twenty-seven adults from the Cincinnati, Ohio area average 19.6 grams. At the age of 20 days the mice are approximately one-half grown and at 30 days are two-thirds grown. By combining this information with the pelage data presented above we have a basis for estimating the approximate age of deer mice taken in the field.

SUMMARY

Deer mice from the Ithaca, New York region and the Cincinnati, Ohio area were studied to determine the characteristics of pelage change. All litters studied were from pregnant females live-trapped in the field. The mice were kept in large, outdoor screen cages. The molt from the deep mouse-gray juvenile pelage to the cinnamon-rufous pelage, although varying in some small details, appears to follow a definite pattern. This is true for both males and females. The new fur first appears as a small patch immediately in front of, or above the hind leg. It then progresses forward along either side. The gray dorsal stripe is the last to disappear. Most mice complete the entire molt within three and one-half weeks. Ninety-five per cent of the animals start the pelage change between 40 and 50 days of age; males have a tendency to molt sooner than females. Weight and the onset of molt are not directly related. The factors affecting pelage change are not apparent although the endocrine system may possibly play an important role. The size of the animal, together with observations made on its pelage, may be used in establishing fairly accurately the age of a deer mouse in the field.

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SIGHT OBSERVATIONS OF COLORADO MARTENS, 1950–1955

By Lee E. Yeager and Jack D. Remington

During the 6-year period of 1950–1955 the writers gathered a total of 66 sight records of the pine marten (*Martes americana origenes* Rhodes) in Colorado. These records were supplied by 33 observers whose reliability is unquestioned; other records were discarded because of incompleteness or other shortcomings. Observation of 17 of the 33 individuals extended over the entire 6-year period.

The 66 records are from seven counties (Garfield, Grand, Jackson, Larimer, Pitkin, Rio Blanco, and Routt), the gross area extending about 130 miles east and west and 120 miles north and south. It is considered that these boundaries contain about two-fifths of the marten range in Colorado.

It is emphasized that these data, based solely on chance observation, are not quantitative in nature; they are not suitable for other than very general interpretation. In several instances, however, the preponderance of records by cover types or at certain times of the year appear so clearly to indicate trend, preference, or habits in the marten that they seem worthy of record.

Population trend.—The increase in the number of marten sight records is particularly noticeable for 1954 and 1955. The trend during the last five years is as follows: 1951—2; 1952—5; 1953—6; 1954—13; 1955—19. The collection of 21 records in 1950 is discounted since the junior author was then engaged in full-time marten studies and made special efforts to obtain all possible observations.

The writers believe that the marten population in Colorado is increasing, but the nature of the data at hand precludes a more positive statement. The progressive increase in the number of records cited, however, is parallel to more quantitative information collected by the senior author since 1950 in connection with studies in beetle-killed spruce-fir forests (Yeager and Riordan, 1953, and unpublished), Table 1.

It is recognized that weather and other factors affect the detection of animal sign. Comparability in collection is assured in the present case, however, since the same routes (including trails, blazed lines, logs and rocks) were followed at the same season (September, prior to snowfall) in inspecting 100 quarter-acre plots during the 6-year period. The amount of time devoted to plot inspection was almost exactly the same each year. Parallelism in the two sets of data, regardless of their non-quantitative nature, suggests increasing marten numbers.

Reasons for increase are not difficult to ascribe. The two most obvious are

Table 1.—*Marten sign in dead spruce-fir timber, Colorado*

Year	Sight record	Scats	Tracks	Total
1950	0	6	1	7
1951	0	8	0	8
1952	1	7	2	10
1953	0	10	2	12
1954	0	16	1	17
1955	0	21	2	23

low pelt prices and the high level, and high wage scale, of employment. Prevailing since about 1948, both factors have tended to reduce the volume of trapping on Colorado's 30,000 square miles of tolerable to excellent marten range. Trends in catch and value have been determined by Yeager *et al.* (1949) and others: for the season of 1946–47, a total of 1,460 martens were taken, and sold at an average of $19.28 per pelt. The estimated catch for 1953–54 (Remington, 1954) was 483, and the average selling price was $8.74. It is certain that the catch in 1954–55 was smaller still.

This decline in catch has made the factor most likely to obscure population fluctuations in a species having commodity value—variable harvests as determined by sale price—relatively inoperative in Colorado since about 1950. If this trend continues long enough, and if dependable population indexes can be developed and executed in time, students may be afforded an unusual opportunity to inquire into cyclic behavior and other aspects of population dynamics peculiar to this member of the weasel family.

Midsummer activity.—That the breeding season in the pine marten occurs about midsummer is well known. Sight observations of martens, by months, were as follows: February, 1; May, 1; June, 15; July, 19; August, 12; September, 5; and October, 13. The preponderance of observations in June, July and August—46 of 66, or 70 per cent—suggests that the animals may be more prone to diurnal activity during the breeding season than at other times of the year.

In evaluating these records, consideration should be given to the lack of observations during winter and early-spring months, due mainly to the scarcity of observers on marten range. June is the first month of the year that appreciable numbers of persons get into spruce-fir timber. An increase in the number of observations in June and later may, therefore, be expected. However, this does not hold for August, September and October, when high-country travel probably reaches its annual peak.

That breeding activities may be partly responsible for the increased number of mid-summer observations is further suggested in the division of June, July and August records. Of the 46 observations for these three months, 38 (83 per cent) were during the last half of June, July, and the first half of August, the bi-weekly figures for this two-month interval being 8, 9, 10 and 8, respectively. Only 4 martens were recorded for each of the two-week periods of June 1–15 and August 16–31.

In these observations the frequency of occurrence by two-week periods indicates that the overall breeding season in wild martens may extend from about mid-June to mid-August. These dates compare generally with the breeding period in captive martens, as reported by Ashbrook and Hanson (1927, 1930) and Schmidt (1934).

The comparatively large number of observations in October is attributable mainly to the great number of hunters in marten range at this time. That 10 of the 13 October records were obtained during the last half of the month is logically associated with the big-game hunting season which, except in 1953, opened each year on October 15 over most of the marten range. In 1953 it opened on October 24. Five of the 10 hunting-season records were at or near deer or elk

TABLE 2.—*Marten observations by elevation and timber type, Colorado*

Elevation, feet	No. of martens observed	Timber type	No. of martens observed
7,000– 8,000	1	Ponderosa pine—aspen	3
8,000– 9,000	11	Lodgepole pine	10
9,000–10,000	19	Lodgepole pine—spruce	10
10,000–11,000	27	Spruce—fir	36
11,000–12,000	2	Above spruce—fir (in timberline	7
12,000–13,000	6	growth, mostly spruce)	
Total	66	Total	66

kills, indicating that a localized food supply may influence temporary concentration and diurnal activity of the animals. Somewhat similar observations were reported by Marshall (1951).

Occurrence by elevations and timber types.—Occurrence of a preponderance of the records in the spruce-fir timber type, 9,000–11,000 feet, is fully in accordance with many previous observations. Sixty-three of the 66 sight records were in the coniferous forest types generally above 8,500 feet. The three exceptions were in ponderosa pine-aspen stands immediately adjacent to (below) lodgepole pine. Association by elevation and timber type is shown in Table 2.

Miscellaneous observations.—The division between morning and afternoon observations was not pronounced, the records being 26 and 36, respectively. Time is unknown for 4 observations. In morning observations, 7 were obtained by 9:00 a.m. and 18 between 9:00 a.m. and noon. Of afternoon records, 17 were taken before, and 18 after, 3:00 p.m. The hour was not given in 6 instances.

No clear correlation of observations with weather was obtained. Martens were seen under all sky conditions, bright sunshine to heavy snowstorm. Twenty-four observations were obtained in "clear" weather; 22 in "cloudy" weather. The weather is unknown for 20 observations.

Don Gore, Colorado Game and Fish Department, reported an interesting observation for July 7, 1950, near Lake Agnes, Jackson County, at an elevation of about 10,300 feet. Mr. Gore encountered an adult marten with four young in the trail. At first the adult, presumably a female, ". . . growled and showed her teeth, but stood her ground. After a couple of minutes she turned off the trail and ran to a rock pile 30 yards away. Two of the young followed but the other two remained in the trail. The female circled back to the trail and tried to get the two to follow, but they continued to look at me. After perhaps half a minute she caught one by the neck and, acting very mad or scared, dragged it to the rock pile, the other kit following behind."

Keith Hay and Duncan MacDonald reported another interesting observation for July 30, 1955, in camp near Big Creek Lake, Jackson County, elevation about 9,000 feet. In this instance the marten ran through the camp, evidently attracted by a kitten; it then climbed a lodgepole pine across a small creek about 40 feet from the tent and remained there for several minutes, making a chuckling noise all the while. It seemed fascinated by the kitten, which had to be restrained to keep her from dashing after the marten.

W. M. Tracy, U. S. Forest Service, observed a marten at an elk kill near the Williams Fork River, Grand County, on October 16, 1954. The elk had been shot early during the day before, and Mr. Tracy and his hunting partner were loading the skinned quarters on a horse at the time of observation. The marten was feeding on the viscera, but soon climbed a lodgepole pine where, perched on a branch ten feet above the ground, it hissed and chuckled for several minutes. Presumably the same individual was observed at the kill during the two succeeding days.

Numerous observers reported marten sight records characterized by "curiosity" or "wary, but unalarmed" behavior. Only one record was received of a marten dashing precipitantly away upon discovering the observer.

Acknowledgments.—The writers obtained sight records of martens from a total of 31 individuals other than themselves. The provision of these records for our use has made possible this report. Our grateful acknowledgments are to the following:

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RANGE AND SPREAD OF THE GRAY AND THE FOX SQUIRRELS IN NORTH DAKOTA

By Edmund A. Hibbard

Although the fox squirrel (*Sciurus niger*) and gray squirrel (*Sciurus carolinensis*) now occupy much of North Dakota, a survey of the literature shows that although Hibbard (1954) had made a preliminary report on these species, only the gray squirrel had previously been reported for the state. Bailey (1926) reports it as occurring at Wahpeton (Richland County), Fargo (Cass County), and Valley City (Barnes County). He does not list the fox squirrel nor does he mention it as possibly occurring here. This species apparently moved into the state from South Dakota and Minnesota, largely within the last 20 years. As can be seen from the map (Fig. 1), its principal range is in the southeastern portion of the state and along the Missouri River and its tributaries. Its range is not continuous in southern North Dakota for it is not found in most of the undrained prairie country lying between the James and Missouri rivers. This region is largely treeless and forms a natural barrier to any woodland species.

Distribution and invasion patterns of the fox squirrel.—In southeastern North Dakota the fox squirrel is found along all the wooded streams, in tree claims, and in the older shelter belts. Most of these shelter belts were planted by the U. S. Forest Service in 1937 and 1938 and, although still immature, they already furnish good squirrel habitat. Probably the heaviest population is found in the three southeastern counties which contain many old tree claims or windbreaks interspersed with numerous cornfields.

The rate of spread of the fox squirrel in the state is interesting. Lerraas (1942) records it from Barrett, Minnesota, in 1932. This is approximately 35 miles east of the southeastern corner of North Dakota. Apparently it first came into the state in this region, for reports from long-time residents of Richland County indicate it appeared there about 1934 or 1935. From this point it moved north and west, reportedly reaching the Maple River in southern Cass County about 1937, the James River in northern LaMoure and southern Stutsman counties about 1939, the Arrowwood Refuge headquarters on the James River in northern Stutsman County in 1944, and shelterbelts in southern Dickey County about 1946.

The northernmost recent record is a specimen obtained at Pleasant Lake in northwestern Benson County. A small colony living here in an isolated grove of bur oak (*Quercus macrocarpa*) was first noted in 1948. This area is located 45 miles south of the international boundary.

A similar spread of this species can be traced on the Missouri watershed. Here their range is confined almost entirely to drainages supporting sufficient tree growth. Most shelterbelts and other tree plantings in this part of the state are too immature and widely separated to attract and support squirrels. On the Missouri River in southern Emmons County farmers report this species appeared about 1942. Following the river, it reached Bismarck in 1946, where it is now quite common along the bottomlands in Burleigh County and is occasionally

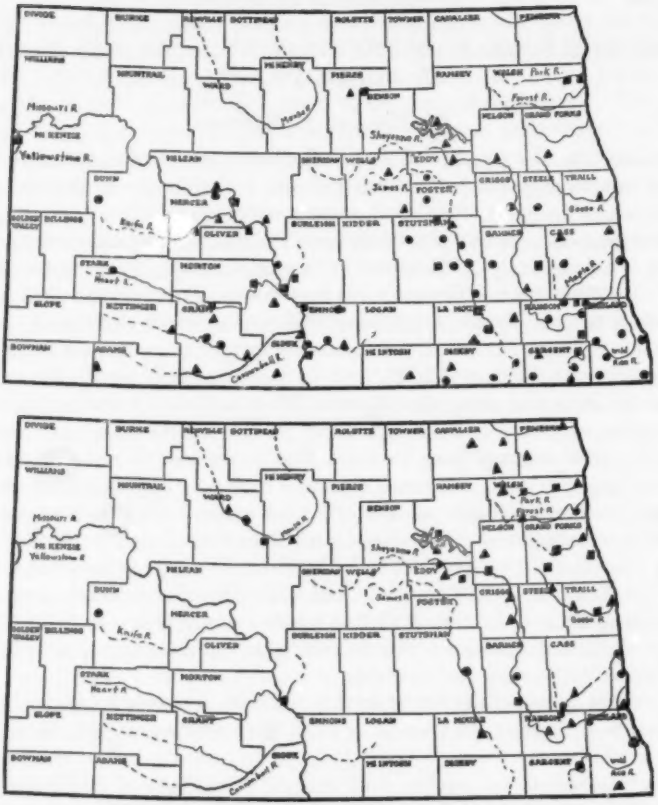

FIG. 1.—TOP: Fox squirrel range in North Dakota. BOTTOM: Gray squirrel range in North Dakota. Key to legend is the same for both maps: Squares = Specimens available; Circles = Personal sight records or road kill observations; Triangles = Reliable reports. Only those portions of rivers traced in a solid line support timber growth sufficient for squirrels.

hunted. Here tree growth consists mainly of American elm (*Ulmus americana*), green ash (*Fraxinus pennsylvanica lanceolata*), and cottonwood (*Populus deltoides*). Small areas have been cleared for agriculture, and corn is one of the crops commonly planted. This combination of scattered timber and corn furnishes excellent squirrel habitat.

From the Missouri River the fox squirrel seems to have spread up the various major tributaries, reaching a point on the Heart River north of Carson (Grant County) about 1948, and an area on the north fork of the Cannonball River south of Carson in 1951. It is also found along the Knife River at several points where it was first noted at Beulah (Mercer County) in 1951. It was found on the Missouri River above the town of Garrison near the Garrison Dam (McLean

County), prior to the formation of the Garrison Reservoir. It is not known how far this species had moved up the Missouri River before the dam was closed, but apparently it was not very far, for the author could find no records of it above Elbowwoods in McLean County.

Introduced fox squirrel populations.—Through introduction, fox squirrels occur in two additional areas of North Dakota and in adjacent Montana. One of these areas is the Yellowstone River Valley in McKenzie County where a sizeable colony of fox squirrels exists. Here they are found in the natural tree growth along the river and also in the numerous planted groves of cottonwoods, some of which are 50 years old and afford excellent habitat. These squirrels are the results of an introduction of five animals of unknown sex by Clayton Worst, who imported them from Indiana about 1941. Since this time they have been reported from as far up the Yellowstone River as Sydney, Montana, and have been seen along the Missouri River west of Williston, North Dakota.

Another area where this species has been released is in the Killdeer Mountains in Dunn County where six squirrels were released in 1953 and 12 more in 1954. These were obtained by North Dakota Game and Fish Department biologists from the Missouri River at Bismarck and consisted of six males and 12 females. The Killdeer Mountains are a small area of high hills in the western part of the state which support a good growth of hazelnut (*Corylus americana* and *C. cornuta*) and bur oak. Present indications are that the fox squirrel is doing quite well here.

There have been two other known introductions into the state that may have augmented local native populations. One of these was at Jamestown (Stutsman County) where two pairs were released by Clyde Livesay in 1938. Another series of introductions, totaling about 50 animals since 1935, has been made on the Missouri River at Washburn (McLean County) by Mr. R. T. Anderson with squirrels obtained from central Minnesota. The dispersion pattern of these animals is not clear, but apparently this population, supplemented by the invading population from downstream, has been the source of squirrels along the upper reaches of the Missouri River and its tributaries.

Isolated fox squirrel records.—There are several records of the fox squirrel that are out of the main range for the species in North Dakota. Two of these are for extreme southwestern North Dakota in Adams and Stark counties. These isolated records probably represent only the range of erratic individuals. One of these was an individual seen by the author in August, 1953, on the Heart River at Dickinson in Stark County. This was the first known appearance of this species there. The flooding of the Heart Butte Reservoir in northwestern Grant County in the fall of 1949 has probably prevented any large scale movements up this river.

The other record for southwestern North Dakota was an individual seen one and one half miles west of Reeder in extreme western Adams County. This animal was sighted on September 11, 1953, by a fisheries biologist, John Hewston, in an area devoid of tree growth and with no suitable squirrel habitat within 50 miles except for a few plantings made around farm yards and in towns.

Two other records for the northeastern part of the state also do not fit the rest of the range picture. One of these is that of three animals collected by Frank Vejtasa near the mouth of the Park River (Walsh County) in 1921. The other, a specimen in the University of Michigan, Museum of Zoology collection, was taken in 1936 near Grafton, a few miles up river from this point. Mr. Vejtasa states that the three animals, all collected at one time, are the only fox squirrels he has ever seen in northeastern North Dakota. No other more recent occurrence of this species is known from this area. Possibly these animals came from an introduction or migration of fox squirrels that later died out. However, the fact that Gunderson and Beer (1953) record it from Norman and Polk counties in Minnesota, opposite Traill and Grand Forks counties in North Dakota, indicates that this species may be working further northward along the Red River.

From the above information it is apparent that the fox squirrel has spread over a large portion of North Dakota within the rather short span of 20 years. This extension of the species' range is still in progress for there is potential habitat that is not occupied by this squirrel. Each year since the author began taking notes on the species, there have been new reports of its recent occurrence that have extended its known range. Some of these have been of vagrant individuals, but others of resident squirrels. Especially interesting are the appearances of this squirrel in isolated farm groves or shelterbelts. In order to reach many of these the animals had to travel many miles from other suitable habitat.

Distribution pattern of the gray squirrel.—The gray squirrel is quite common now in parts of North Dakota. Within the last 35 or 40 years it has extended its range from the Red River at Wahpeton and Fargo northerly and westerly until now it is found in suitable areas throughout the northeastern third of the state. Except in areas where it has been introduced, this species is largely confined to the Red River and its tributaries. It is present all along this river in North Dakota and, according to Soper (1946), has extended its range as far north in Manitoba as Lake Winnepeg.

In North Dakota this squirrel is mainly confined to areas of natural tree growth that contain at least some oak. Hence its range in this prairie state is limited almost entirely to rivers and the fringes of timber found around a few lakes, such as Devils Lake. It occurs in most towns in the northeastern part of the state and is occasionally found in shelterbelts, especially those in close proximity to rivers. In the Larimore-Kempton vicinity in Grand Forks County this species is quite common in the numerous tree plantings. This squirrel is found in only one other habitat type. This is the timberland slopes of hilly areas such as the Pembina Hills of Cavalier and Pembina counties, and the Killdeer and Turtle Mountains.

In the latter area the gray squirrel has been present only a short time and is not well established. It is known only from a few scattered areas where second-growth bur oak is the dominant tree. These "mountains" are an area of high, rolling hills, approximately 30 x 40 miles in diameter, which straddle the United States-Canadian line in Bottineau and Rolette counties. Formerly, hardwoods covered much of the Turtle Mountains, but fires have created a forest consisting

predominantly of aspen (*Populus tremuloides*), which provides very little gray squirrel habitat. In order to get to this area from the south or east, squirrels would have had to cross a large expanse of prairie, for there are no records closer than 50 miles in these directions. They could, however, have come in from the north, for Soper (*loc. cit.*) lists a record from north of Treesbank, Manitoba, which is only about 45 miles north of the border above St. John in Rolette County. More recently Mr. R. W. Sutton (1955) of the Manitoba Museum at Winnepeg reports gray squirrels from four miles north of Ninette, Manitoba, which is only about 30 miles from the Turtle Mountains.

Gray squirrel introductions.—In some areas of the state the gray squirrel occurs locally through introductions. This accounts for the scattering of records on the range map. Known areas where it has been introduced are as follows: (1) Jamestown: It was reportedly introduced here about 1904. On the James River it is much less common than the fox squirrel and has a limited range. (2) Bismarck: In 1944 Mr. Robert Webb released approximately 30 gray squirrels on the Missouri River north of town. They were fairly common for a time, but have now been largely replaced by the fox squirrel. The author has seen only one specimen from the Missouri River. It was taken in a live trap in June, 1954. (3) Minot (Ward County): In April of 1915 the park board placed 12 squirrels in the Minot City Park on the Mouse River. By 1935 they had moved at least as far as Verendrye in McHenry County. This is the only area in the state where the author has seen the black phase of the gray squirrel, although melanistic specimens also occur at Devils Lake. (4) Killdeer Mountains: In 1951 and 1952 a total of 12 gray squirrels were obtained from Burlington, Wisconsin, and planted at the ranch of Jack Murphy in the bur oak woodland surrounding the edge of these hills. They have since multiplied and spread to several neighboring farms. (5) Valley City: Bailey (loc. cit.) mentions an introduction of gray squirrels here sometime previous to 1912. Possibly this is the source of gray squirrels along the upper Sheyenne River.

This squirrel has been a resident of eastern North Dakota for a long time. Bailey (loc. cit.) quotes O. J. Murie as stating that the species has been along the Red River Valley at Fargo at least since 1906. By 1919 it was quite common on both sides of the Red River. There are further indications that it has existed along most of the Red River drainage since the early 1920's. Farmers along the Sheyenne in Griggs County told the author that the gray squirrel had been there since about 1925. Mr. Frank Vejtasa, a taxidermist from Fairdale (Walsh County), states that he first took a specimen of this animal in 1921 near that town. However, it has been only since about 1930 that the species has been at all common in the latter area.

Portions of the above information were obtained from the author's notes made between December, 1951, and July, 1953. The completion of this work was made possible by Pittman-Robertson Project W-36-R, of the North Dakota Game and Fish Department. The author thanks the following persons who helped obtain information: various North Dakota Game and Fish Department personnel, especially Richard Mill and Edwin Bry, who furnished information on gray

squirrels in the northeastern part of the state; Robert Randall and assistants of the U. S. Fish and Wildlife Service, Bismarck, North Dakota, who obtained several records of fox squirrels in the Missouri drainages; Mr. Frank Vejtasa of Fairdale, North Dakota, who gave the author several early records for the gray squirrel; and Dr. Frank Cassel of the North Dakota Agricultural College for encouragement and helpful criticism.

The following list of study skins and skulls are on deposit at the North Dakota Agricultural College, Zoology Division, at Fargo, North Dakota. Where they are available, specimen numbers and dates of capture are given:

Fox squirrel. Specimen #23—Pleasant Lake (Benson Co.), 2–19–54; #28—6 mi. N. Geneseo (Sargent Co.), 3–3–54; #41—Mouth of Little Beaver Creek (Emmons Co.), 10–5–54; #47—3½ mi. N.W. Hensler (Oliver Co.), 10–20–54; #50—2 mi. S. Dore (McKenzie Co.), 10–15–54; #55—2 mi. S. Riverdale (McLean Co.), 10–?–54; #56—11 mi. N., 4 mi. W. Carson (Grant Co.), 1–6–55; #59—2 mi. N., 3 mi. W. Dickey (Lamoure Co.), 1–20–55; #63—5 mi. S., 1 mi. W. Leonard (Richland Co.), skin only, 2–11–55; and #84—4½ mi. W. Windsor (Stutsman Co.), 6–15–55. Three specimens collected by Agriculture College personnel from 10 mi. W. Tower City (Barnes Co.), and two Ransom County specimens from 5 mi. S.W. McLeod and 8 mi. E. Enderlin. There are skulls only from the following locations: 3 mi. S. Bismarck (6–12–54), and 1 mi. N. Menoken (2–?–54), both in Burleigh County.

Gray squirrel. Specimen #35—2 mi. S. Bismarck (Burleigh Co.), 6–12–54; #40—1 mi. N. Kathryn (Barnes Co.), 9–21–54; #42—2½ mi. S.W. Pekin (Nelson Co.), 9–30–54; #45—20½ mi. E., 2 mi. N. New Rockford (Eddy Co.), 9–30–54; #46—7 mi. W., ½ mi. N. Park River (Walsh Co.), 10–15–54; #49—4 mi. S.W. Velva (McHenry Co.), 10–21–54; #51—Kempton (Grand Forks Co.), 10–14–54; #58—3 mi. W. Devils Lake (Ramsey Co.), 10–22–54 (a melanistic specimen); 1 mi. E. Hillsboro (Traill Co.), skull only, 10–14–54.

There are also the following known specimens available at other institutions. *Gray squirrel:* a road kill found 9–29–33 on U.S. Highway #81 a few miles S. of Grank Forks (Grand Forks Co.), in the Bismarck Historical Museum; Grafton (Walsh Co.), in the Univ. of Michigan, Museum of Zoology collections; Arvilla (Grand Forks Co.), in the Univ. of N. Dakota, Biology Dept., skull only, 3–5–42. *Fox squirrel:* Grafton (Walsh Co.) Univ. of Michigan Museum of Zoology, 1936; near mouth of Park River (Walsh Co.) in collection of Frank Vejtasa, Fairdale, N. Dakota, three animals collected in 1921.

Summary.—From the available reports it appears that the fox squirrel first entered eastern North Dakota in the early 1930's. There were two probable invasion routes. It apparently came into southeastern North Dakota from Minnesota and into central North Dakota via the Missouri River from the south. It first appeared in the latter area about 1942. The natural spread of the species was augmented at several points through introductions. In some areas colonies were established by this method. The densest population of this species is found in shelterbelts and along rivers in southeastern North Dakota. Good populations also exist on the Missouri River and the lower portions of its major drainages.

The range of the fox squirrel is in a state of expansion for the species is continually moving northwesterly while invading further into prairie areas that contain only isolated tree groves.

The gray squirrel has spread over much of the northeastern part of the state during the last 40 years. It also occurs in several isolated areas through introduction. This species is restricted almost entirely to timbered river valleys and the few upland oak areas, although it does occur occasionally in older tree plantings in eastern North Dakota. It has reached the Turtle Mountains in only recent years. This area contains its chief potential range.

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NOTES ON PANGOLINS OF THE IVORY COAST

By U. Rahm

During my three-year stay on the Ivory Coast I had an opportunity to collect material on pangolins inhabiting this region of West Africa. Since these animals are under severe protection I abstained from killing or capturing any, but confined myself to material obtainable from Europeans or natives. I take this opportunity to thank Mr. Gorse, Inspecteur des Eaux et Forêts, and Dr. Vogeli-Zuber for their valuable help. Observations made on living specimens of *Manis tricuspis* and *Manis longicaudatus* have been published elsewhere (Rahm, 1955).

Of four known African species of manids, three inhabit the Ivory Coast, West Africa:

1. Giant pangolin: *Manis* (*Smutsia*) *gigantea* (Illiger). This animal measures approximately 150 cm., its tail is massive and broad, the forelimbs bear scales to the base of the claws.

2. Tri-cusped pangolin: *Manis* (*Phataginus*) *tricuspis* (Raphinesque). The tail is only a little longer than the body. The scales are small, numerous, brown and often tri-cusped.

3. Black-bellied pangolin: *Manis* (*Uromanis*) *longicaudatus* (Brisson). The tail is twice as long as the body. Scales are comparatively large, yellowish and brown coloured.

FIG. 1.—Places where pangolins were found on the Ivory Coast, Africa.

Manis (Smutsia) gigantea (Illiger).—Neither living specimens nor whole skins of the giant pangolin were obtainable, the only evidences of this animal were scales and a rather large piece of skin. This may be due to the fact that the natives are very keen on the meat and roast the killed animals unskinned, possibly they remove the scales one by one. I have records from the following places: Man (frontier towards Liberia—Guinea), April, 1952. A reasonably large piece of skin in possession of a European. Yapo—North (50 km. north of Abidjan), March, 1953. A great number of dorsal and tail scales. The animal was killed in the tropical rain forest of Yapo towards the end of 1952. Adzopé (120 km. northeast of Abidjan), October, 1954. Large piece of dorsal mail with complete tail-base. Killed by a farmer in the same year near Adzopé. Gagnoa, November, 1954. Some dorsal scales.

Dorsal scale measurements for the three regions were as follows for length and breadth: Yapo, 7–7.5 cm. and 9–10 cm.; Adzopé, 7.5 cm. and 10.5 cm.; Gagnoa, 7 cm. and 10 cm.

These few facts provide valuable information, since *Manis gigantea* has not yet been reported for the Ivory Coast, or even the whole region of French West Africa. Dekeyser (1953) writes: "... On ignore, en définitive, si le Pangolin géant (S. gigantea) existe dans la portion occidentale proprement dite de l'Afrique Noire." Malbrant et Maclatchy (1949) mention mountainous woods as the principal biotope. Concerning the Ivory Coast this applies only to Man, the other finding places are in the tropical rain forest region proper.

Native names are Baoulé, *Pralé* or *Kokoroko*; Aby, *Olobé*; Attié, *Yekpo*; Bété, *Zoné*; Gouro, *Zè* or *Gouli*.

Manis (Phataginus) tricuspis (Raphinesque).—*Manis tricuspis* (Raphinesque

TABLE 2.—*Collecting localities and measurements of Manis longicaudatus*

Date	Locality	Sex	Head—body, cm.	Tail, cm.	Scale number		Weight, gm.
					Back	Tail	
6. 5.54	Adiopodoumé	m	32	59	11	43	1530
8. 7.54	Toupah	?	33	63	12	43	Skin
24.10.54	"	?	33	60	11	45	Skin
30.10.54	Abidjan	f	21	36	10	43	?
14.12.54	Daloa	m	30	59	11	45	1180
10. 2.54	Attoutou	Some scales only					

1821), *Manis multiscutata* (Gray 1843), *Manis tridentata* (Focillon 1850). Of the three species of pangolins in the tropical rain forest region of the Ivory Coast, *Manis tricuspis* is the most frequent. Also in the territory of French Equatorial Africa and in the Congo *Manis tricuspis* is more numerous than the others, Malbrant et Maclatchy (1949), Hatt (1934). Specimens were found as indicated in Table 1. The localities Niangon Lokowa, Abadji Kouté, Niangon Adjamé and Adiopodoumé are neighbouring villages of the Swiss Research Centre, 17 km. west of Abidjan. Moreover the existence of *Manis tricuspis* at the following places of the Ivory Coast has been proved by skins that I found in the possession of natives: Adjaké, Assakra, Azaguié, Bouaké, Douékoué, Tai, Toupah, N'zida. It follows from the above that *Manis tricuspis* inhabits the whole tropical rain forest area in the Ivory Coast, including the so-called "Savane Baoulé" in the middle of the territory. In literature the existence of *Manis tricuspis* in the tropical forest of Guinea, as well as the whole Congo forest is reported by Bates (1905), Cansdale (1948), Teannin (1936), and Monard (1935).

Cranial measurements in millimeters of *Manis tricuspis* for specimens 4.12.54 and 15.9.53 follow: greatest length, 66 and 64; height, 21 and 24; breadth, 32 and 31. The measurements range within the figures given in literature for other localities of West Africa. The head-body length varies for adult animals between 30 and 41 cm., the tail measures between 36 and 60 cm. The number of scale rows from neck to base of tail amounts to 20 or 21. The median scales of the dorsal side of the tail vary between 34 and 41. There is a striking individual variation regarding tail length, which is independent from number of tail scales, body length or sex.

Back and flanks of the body, the upper side of the head, the outer side of the upper forelimbs and of the whole hind limbs and the tail are scaled. The smallest scales are on the head, whilst those on the limbs and on the flanks are somewhat larger and have a very distinct median longitudinal keel. Two specially large scales are in the region of the shoulder blades. An average dorsal scale is 1.8 cm. broad and 4 cm. long. All scales have more or less strongly developed longitudinal grooves. All scales of juvenile animals are of about the same size, distinctly grooved and tri-cusped at the point. The number of scales remains constant during adolescence, the dorsal and tail scales increase in size only. The dorsal scales of adult animals are conspiciously worn off. The tri-cusped shaped may be com-

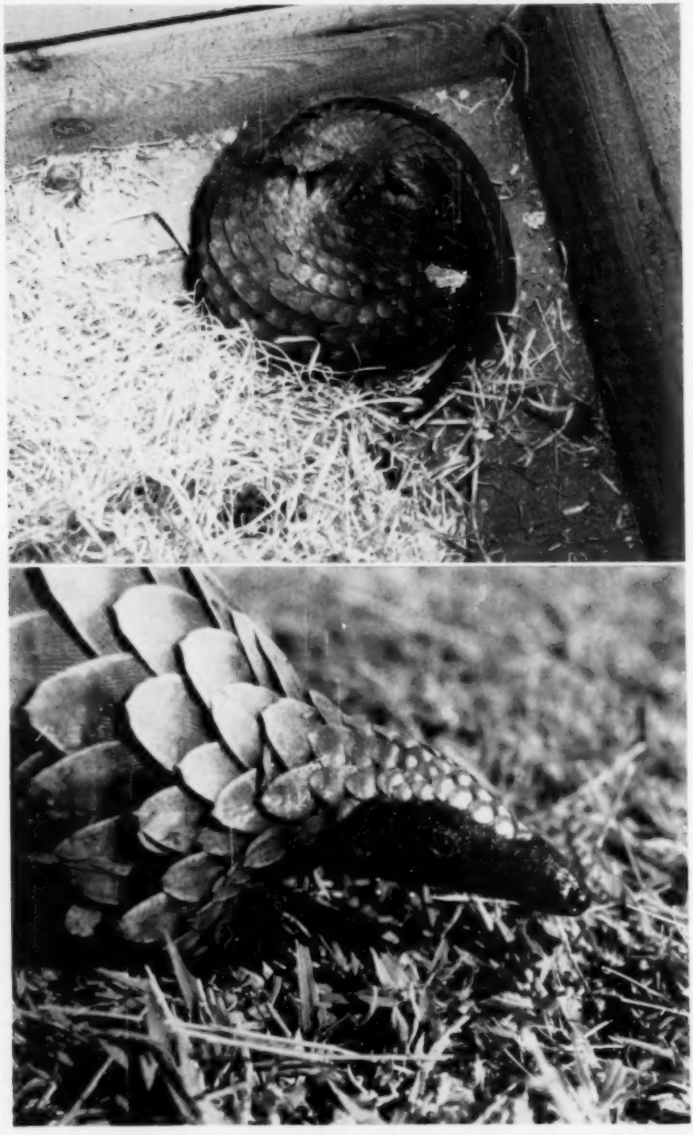

PLATE I

TOP: Female *Manis tricuspis* rolled up, asleep with its baby. BOTTOM: Head of *Manis longicaudatus*.

pletely worn off and the grooves are frequently wiped out. As I mentioned elsewhere (Rahm, 1955) this is due to an active wear on these scales when *Manis tricuspis* endeavours, after feeding, to get rid of termites adhering to its body. The colour of scales in adult animals is uniformly brown, the base of the scale is occasionally coloured faintly yellowish. The colour of juvenile animals is uniformly light grey and differs from that of adult specimens. The skin of unscaled body parts is light brownish-grey and covered with short scarce hair of brownish colour. The skin of a new-born animal is pink and the hair appears only three weeks after birth. *Manis tricuspis* has five digits on each forelimb and hind limb. Thumb and big digit are undeveloped and inserted somewhat behind the other digits. The enormously developed digging claw of the third digit is a characteristic feature. No differences in the external appearance of the two sexes are visible. The present material corresponds with the specimens of *Manis tricuspis* described hitherto, and no subspecies have been reported. The tongue of *Manis tricuspis* is 16–18 cm. long, thin, round, and pointed at the end. The stomach is of simple structure, the foremost part has glands, the posterior part is simply folded. The average length of the intestine is 200 cm.

Manis (Uromanis) longicaudatus (Brisson 1762).—*Pholidotus longicaudatus* (Brisson 1762), *Manis macroura* (Erxleben 1766), *Manis africana* (Desmarest 1820), *Manis longicaudata* (Sundewall 1843), *Manis guineensis* (Fitzinger 1822). *Manis longicaudatus* is comparatively rare on the Ivory Coast. Whereas I saw 18 living specimens of *Manis tricuspis*, I obtained only three living *Manis longicaudatus* in the same period. Table 2 gives data on localities and measurements. The cranial measurements of Specimen 6.5.54 are: greatest length, 70 mm.; height, 25; and breadth, 32.

TABLE 1.—*Collecting localities and measurements of Manis tricuspis*

Date	Locality	Sex	Head—body, cm.	Tail, cm.	Scale number		Weight, gm.
					Back	Tail	
3. 2.52	Man	?	30	36	20	36	?
3. 2.52	Man	?	32	38	20	36	?
3. 2.52	Man	?	37	46	21	34	?
22. 2.52	Adiopodoumé	f	15	21	?	?	200
3. 9.53	Niangon Adjamé	m	33	49	21	38	1200
11. 9.53	" "	f	29	42	21	37	1000
15. 9.53	Adiopodoumé	f	41	49	21	38	1650
19. 9.53	Adzopé	m	22	30	20	37	?
9.11.53	Abadji Kouté	m	34	54	21	37	1400
31.12.53	Adiopodoumé	f	20	30	21	39	425
5. 1.54	"	f	34	40	20	41	1190
13. 5.54	Niangon Adjamé	m	37	60	20	40	2780
11. 6.54	Niangon Lokowa	f	33	50	21	39	1690
26. 7.54	Niangon Adjamé	f	28	?	20	?	960
3.10.54	Niangon Lokowa	f	34	51	21	41	1280
4.12.54	Adiopodoumé	f	39	55	21	40	1600
14.12.54	Gagnoa	m	20	22	20	35	?
5. 1.55	Abidjan	f	14	17	20	36	140

All localities are in the tropical rain forest proper of the Ivory Coast. Toupah (60 km. west of Abidjan), Attoutou (dunes between lagoon Ebrié and Gulf of Guinea), Adiopodoumé (17 km. west of Abidjan). In the literature, Bigourdan et Prunier (1937) mention *Manis longicaudatus* for the Ivory Coast, unfortunately without exact dates regarding locality and measurements. The other authors mention the tropical rain forest of the Guinea coast as well as the Congo forest as the habitat of *Manis longicaudatus*.

The present measurements correspond with those given by Hatt (1934) for the Belgian Congo and correspond to the data of other authors. Characteristic of *Manis longicaudatus* is the extremely long tail, which amounts to two-thirds of the total length. As in the case of the tri-cusped Pangolin, this species also has scales on the head, back, flanks, tail and on the outer sides of the limbs. The number of scales is much less than that of *Manis tricuspis* and the single scales are accordingly much larger, i.e., broader. A dorsal scale measures at its basis 5.5 cm. and is 4 cm. long. As in the case of *Manis tricuspis*, the scales of the limbs and of the flanks show a median longitudinal keel and all scales have longitudinal grooves. The scales of head and limbs are yellowish-ocher. The dorsal scales are in the first two thirds dark brown, in the last third towards the point yellowish-ocher, the dark colouring turning gradually to a light shade. The tail scales are dark brown, and show a yellow shade only at the edge towards the point. The colour of the scales does not show much individual difference and it seems that there is no difference between the sexes. The young specimen of 30. 10. 1954 showed a deviation in the uniform pigmentation of the tail-scales. In several instances the brown pigment of a few scales was missing and the scales were of a light, slightly transparent hue. Such defective pigmentations seem to occur sometimes. Hatt (1934) reports a similar case for the Congo. The skin of the unscaled body parts is black and faintly hairy. The hair of the head, forelimbs and chest is black to dark brown, that of the belly and hind limbs, reddish-brown. Digits as well as claws resemble those of *Manis tricuspis*.

The tongue of *Manis longicaudatus* differs somewhat from that of *M. tricuspis*. Its length also measures 16–18 cm., but is somewhat flattened, the cross-section is oval, and the end is not pointed. Three centimeters behind the end of the tongue a surface zone begins of 4 cm. length, which is covered with light coloured bristles 1 mm. long, pointing backwards. The tongue of *Manis tricuspis* has no such bristles. These differences are especially well discernible in fresh material and have as yet, as far as I know, not been reported.

It is interesting that the natives of different tribes of the Ivory Coast do not distinguish in their language between *Manis tricuspis* and *Manis longicaudatus*. Both species have the same names: Guéré, *Nia*; Ebrié, *Krala*; Bété, *Beta*; Attié, *Ababa*; Abé, *Ron'né*; Agni, *Ehoromon*; Baoulé, *Romon* or *Aulemu*; Gouro, *Sampoloné*; Yacouba, *Badin*; Adjoukrou, *Adschrara*.

Parasites.—Ectoparasites: Almost all pangolins, alive or recently dead were infested with ticks. Most ticks preferred to stay under the scales, where they stuck to the soft skin. The greatest number of ticks was found in the region of neck and shoulder. *Manis tricuspis* as well as *Manis longicaudatus* were found to

be infested with ticks of the species *Amblyomma cuneatum* (Neumann) exclusively.

Entoparasites: Most specimens of both pangolin species examined by us proved to be infested with cestodes. The cestodes were found in the gut, sometimes even in the stomach. The worms found were described and classified by J. G. Baer and A. Fain (1955). They belong to a new genus with one species: *Metadavainea aelleni* and to two new species of *Raillietina*, namely *Raillietina rahmi* and *Raillietina anoplocephaloides*.

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A NEW BLACK BEAR FROM NEWFOUNDLAND

By Austin W. Cameron

Examination of a series of nineteen skulls of the black bear (*Ursus americanus*) from eastern Canada reveals the existence of a heretofore undescribed race evidently restricted to the island of Newfoundland. Although the series is small, the characters by which the Newfoundland population can be distinguished from the nominate race are so striking that formal recognition of the island subspecies seems justifiable. This race may be known as:

Ursus americanus hamiltoni subsp. nov.

Type.—Adult male, skin and skull, National Museum of Canada No. 19818, Big Falls, Humber River, Newfoundland; collected July 20, 1949; Collectors:

PLATE I

Top: Skull of the type specimen of *Ursus americanus hamiltoni* showing the great height of the skull in the fronto-parietal region in relation to the total length.

Bottom: Skull of the nominate race (*Ursus americanus americanus*) showing the relatively low, flat cranium in relation to the total length.

Austin W. Cameron, Sherman Bleakney, Marshall H. Ronalds, Lloyd Duncanson; collector's number 27.

Distribution.—Island of Newfoundland

Characters and comparisons.—The most obvious skull characters distinguishing the Newfoundland race from the nominate race are the greater height of the cranium in the frontal region and the relatively shorter rostrum. The skulls of the nominate race are decidedly flattened dorsally; the curvature from the tip of the nasals to the lamboidal crest forming a gentle curve. By contrast, the greatly inflated frontal region of the skull of Newfoundland specimens results in a steep slope both in the naso-frontal and the fronto-parietal regions (Pl. I). The frontal "hump" becomes more pronounced with age, while the rostrum becomes relatively shorter in relation to the height of the cranium.

In determining the degree of variation present in the two populations, the rostral length was divided into the height of the skull and the resultant figures treated as whole numbers. In the series of twelve skulls of the nominate race measured, the value ranged from 142 to 179 with a mean of 156, a standard deviation of the mean of ± 11.2, and a standard error of the mean of ± 3.2. The seven Newfoundland skulls ranged from 167 to 187, with a mean of 174, a standard deviation of the mean of ± 6.5, and a standard error of ± 2.5. These are shown graphically in Figure 1. It is evident that the differences are very significant.

The height of the skull was taken from the pterygo-palatine suture at the edge of the palatine notch (anterior to the hamular process of the pterygoid) to the saggital suture immediately dorsad. The rostral length was measured from the junction of the premaxillaries and the nasals at the edge of the external nares to the inside anterior angle of the zygoma at the posterior opening of the infra-orbital foramen (ventral to the lachrymal).

Measurements of type.—Skin: total length, 121 cm. Skull (in mm.): greatest length, 283.3; condylobasal length, 265.3; naso-occipital length, 234.5; premaxilla to occipital condyle, 268.3; premaxilla to palatine notch, 138.8; mastoidal breadth, 90.6; interorbital breadth, 61.0; zygomatic breadth, 163.1; alveolar

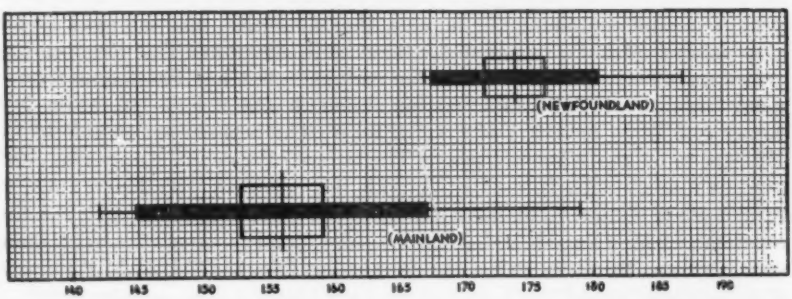

FIG. 1.—Variation in the skull characters of eastern North American black bears. The values were obtained by dividing the cranial height by the rostral length. The single horizontal line represents the range, the solid bars represent two standard deviations, and the open bars represent two standard errors.

length of maxillary tooth row (including canine), 98.2; alveolar length of mandibular tooth row (including canine), 112.5; height of skull, 100.1; rostral length, 57.5.

Acknowledgements.—I am particularly grateful to Captain H. W. Walters, D. H. Pimlott and S. S. Peters of the Newfoundland Department of Mines and Resources and to L. M. Tuck of the Canadian Wildlife Service for their efforts in securing material for the present study.

Remarks.—Because of the extreme development of the frontal region, skulls of the Newfoundland race can be readily selected from the mixed series including those of the nominate race. Skulls of the two races can be quickly segregated even by a person unfamiliar with taxonomic characters.

The new race is named for Professor William J. Hamilton, Jr., of Cornell University, for his outstanding contribution to North American Mammalogy both as a scientist and a teacher.

Specimens examined.—NEWFOUNDLAND: Big Falls, Humber River, Grand Falls District, 2; Sheffield Lake, Green Bay District, 1; Gambo Lake, Bonavista District, 2; Deer Lake, Humber District, 1; Meelpaeg Lake, Grand Falls District, 1. ONTARIO: Pine Lake, Rainy River District, 1; Moose Creek, Russell County, 1; Sturgeon Bay, Thunder Bay District, 1. QUEBEC: Sandy Lake, Pontiac County, 3; Val Jalbert, Lake St. John District, 1. ALBERTA: Wood Buffalo Park, 1. "EASTERN CANADA", 1.

Zoology Section, National Museum of Canada, Ottawa, Ontario. *Received April 18, 1956.*

SECOND FIND OF *THOMOMYS TALPOIDES* FROM LATE PLEISTOCENE IN KANSAS

By Joseph H. Waters

The University of Michigan palaeontological field party, led by Dr. Claude W. Hibbard, collected on August 27, 1953, in Clark County, Kansas, the anterior part of a skull containing the incisors, the left P^3–M^2, and the right P^3–M^1 (No. 31378 U.M.M.P.) of *Thomomys talpoides* (Richardson). This specimen was taken approximately 15 feet below the surface from a late Pleistocene terrace along the east side of Kiger Creek, on the south side of U.S. 160, in the NE corner of NW ¼ sec. 10, T. 33 S., R. 24 W. The deposits are considered by Hibbard to be late Wisconsin in age. The terrace consisted of stream-deposited sand and sandy silts. In association with this specimen were found two left maxillaries of *Citellus richardsonii* (Sabine), one possessing the P^3–M^2, and the other the P^2–M^1 (No. 32461 U.M.M.P.). Also found in association with these specimens was the distal end of the right radius (No. 31377 U.M.M.P.) of one of the extinct bison.

This is the second record of *Thomomys* from the late Pleistocene of Kansas. The first one was collected by the University of Michigan palaeontological field

party on August 3, 1950 (Hibbard, Jour. Mamm., 32: 229, 1951). This specimen consists of the anterior part of the skull containing the incisors and the left and right P^4–M^1 (No. 26953 U.M.M.P.). It was taken in Greeley County, Kansas, approximately six feet below the surface, from a late Pleistocene deposit, along the north bank of Ladder Creek, on the west side of Kansas Highway 27, in SE ¼ sec. 5, T. 16 S., R. 40 W., the range being originally incorrectly published as R. 20 W. (Hibbard, *loc. cit.*). Specimens of *Citellus richardsonii* were taken from the Ladder Creek locality, in the summers of 1947 and 1948, by John Branch and Claude W. Hibbard, in association with *Thomomys*. All of these specimens were taken from a late Pleistocene terrace, which consists of sandy silts.

The bison radius (No. 31377 U.M.M.P.) appears to belong to *Bison occidentalis* Lucas or to *Bison antiquus* Leidy. The distribution of these bison in the late Pleistocene, as shown by Skinner and Kaisen (Bu. Amer. Mus. Nat. Hist., 89: 153–157, 1947, map 2) in the United States, extended from southern Oregon through Virginia and North Carolina and south through Texas. Finds indicate that *Bison antiquus* and *Bison occidentalis* were contemporaneous in the very late Pleistocene. Skinner and Kaisen, map 2, show the location of finds of both species as being in the same general area, which includes Minnesota, Iowa, N. aska, Colorado, Kansas, Oklahoma, New Mexico, and Texas. They consider the age of deposits from which the specimens were taken as being late

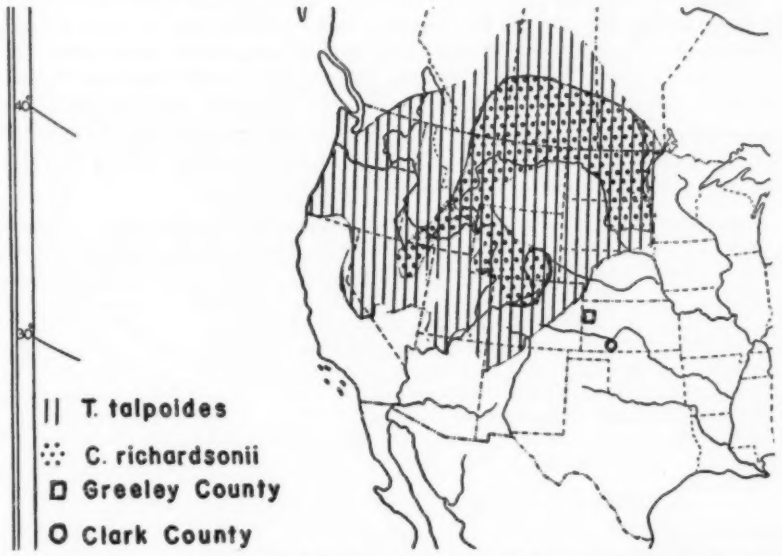

FIG. 1.—Present distribution of *Citellus richardsonii*, Richardson ground squirrel, and *Thomomys talpoides*, northern pocket gopher. Square and circle marks locations of fossil finds in Kansas.

Pleistocene and sub-Recent. Since skeletal material was not available for comparison, it is impossible to determine which species is represented. The greatest transverse width of the radio-carpal joint is 102.5 mm., which is much wider than that of the living *Bison bison*.

The present-day distribution of *Citellus richardsonii* and *Thomomys talpoides* were approximated from the maps in A FIELD GUIDE TO THE MAMMALS (Burt and Grossenheider, 1952), and determined as correctly as possible by checking the ranges of all the subspecies of both species as given in the check-list compiled by Miller and Kellogg (U. S. Nat. Mus. Bul. 205, 1955). These ranges were plotted as accurately as possible (Fig. 1).

As indicated on the map, the Kansas Pleistocene finds of *Citellus richardsonii* and *Thomomys talpoides* are considerably to the east of their present-day ranges. In the case of *Thomomys talpoides*, the Greeley County find is approximately 75 miles from the nearest point of its present-day range, and the Clark County find is approximately 200 miles southeast. This indicates a considerable eastward extension of the range over that of the present day.

The difference is even more pronounced in the case of *Citellus richardsonii*. In this case the Greeley County find is approximately 250 miles away from the present range, and the Clark County find is approximately 375 miles southeast of its present-day range. This indicates either a considerable shrinking, or a westward shift, of the range since the late Pleistocene.

The shift of the range of *Thomomys talpoides* and *Citellus richardsonii* seems to indicate that the climate had changed in western Kansas in the very late Pleistocene. It is impossible to state why their ranges shifted to the north and northwest. It seems from available data that there has been a decrease in precipitation and a slight increase in temperature in this region since the time these mammals were known to live there. Whether the shift in range was due entirely to a change in temperature and precipitation or was due to an indirect effect on the vegetation used as food by these forms is not known.

Department of Vertebrate Palaeontology, University of Michigan, Ann Arbor, Michigan. (Present address of Joseph H. Waters, Department of Zoology, University of Connecticut, Storrs, Connecticut.) *Received January 11, 1956.*

GENERAL NOTES

NOTES ON A CAPTIVE SHORT-TAILED SHREW

On December 3, 1954, one of my students, Don Caldwell, of 102 Western Ave., Findlay, Ohio, was attending a line of bird-banding traps when he found one slightly tilted. Suspecting that there might be a shrew or a mole beneath, he snatched up the trap and reached into the depression that had been excavated beneath it. In this way he secured a live male *Blarina brevicauda brevicauda* in good condition. The specimen was placed in a dry aquarium measuring 21 by 46 inches. The bottom of the aquarium was covered to a depth of one inch with garden soil and a small plastic dish was introduced as a water container. The specimen lived from December 3 until February 21 in the aquarium, when it was found dead. No weights or measurements were recorded for the specimen, but it was of average size for this species. The shrew hollowed out a depression beneath the watering pan and used it for a den. It was fed dead English sparrows, dead house mice, raw hamburger, chicken scratch feed, and on one occasion a live meadow vole (*Microtus pennsylvanicus*).

During the hours of daylight the shrew ventured from its hiding place only when raw meat or a dead animal was placed within a foot of the watering vessel. The shrew kept its den littered with the chicken scratch, which it transported a distance of three feet. During one period of three weeks the specimen was fed nothing but chicken scratch. Of this feeding mixture it preferred the cracked corn.

On the occasion when we introduced the live meadow vole into the aquarium, it was released at the end opposite the one occupied by the shrew. Immediately, the shrew became excited and began rushing about the cage, pursuing the vole. It seemed to follow the scent left by the vole, and several times the shrew ran completely over the vole in its eagerness and had to backtrack to regain the quarry. Finally, the shrew fastened its teeth just behind the left ear of the vole, which exceeded it by several grams in weight, and began to gnaw at the base of the skull. It required 11 minutes for the shrew to kill its prey and during that time it was dragged roughly and rapidly about the cage, as the vole attempted to shake loose from the shrew.

When introduced into the cage at 8:30 AM the vole weighed 22 grams. At 2:30 PM it appeared that the shrew was through feeding and the remains of the vole were weighed. The material remaining was chiefly skin and weighed 8.3 grams; the shrew had consumed 13.7 grams of flesh in a period of 6 hours.—RICHARD STUART PHILLIPS, *834 Liberty Street, Findlay, Ohio. Received February 1, 1956.*

DWARF SHREW FIRST-REPORTED IN SOUTH DAKOTA

In a previous note (Jour. Mamm., 34: 382, 1953) we reported a shrew from 2½ miles north of Fairburn, Custer Co., South Dakota, as *Sorex vagrans monticola* Merriam. Reexamination of the specimen (45218 University of Kansas) convinces us that we were in error in our identification, and that the specimen is instead the dwarf shrew, *Sorex nanus* Merriam. Our identification is based on the small size of the shrew (maxillary tooth-row, 4.8; palatal length, 5.5; least interorbital breadth, 2.5); these measurements are smaller than those of any *S. vagrans* known to us and agree with those of *S. nanus*. To our knowledge this is the first record of *Sorex nanus* from South Dakota.—JAMES S. FINDLEY AND ROLLIN H. BAKER, *Department of Biology, University of New Mexico, Albuquerque and The Museum, Michigan State University, East Lansing. Received January 7, 1956.*

SOME BAT RECORDS FROM SOUTHEASTERN INDIANA

During the summer of 1953 while a student at the University of Kentucky the author began some occasional bat collecting in Ripley and Jefferson counties, Indiana, under the direction of Dr. Roger Barbour. The work has been continued under the direction of Dr. Jack Gottschang of the University of Cincinnati.

During the course of the investigation 176 specimens were examined. Skins and skulls

were prepared of 159 of these specimens and are at present in possession of the author but will later be deposited in the University of Kentucky Zoological Museum and the University of Cincinnati Zoological Museum.

The author acknowledges the aid of Mr. Russell E. Mumford and Mr. James B. Cope for examination and identification of specimens of the species *Myotis* and Mr. Charles O. Handley, Jr. for examination and subspecific determinations of *Pipistrellus subflavus*.

In the following annotated list all measurements are in millimeters; averages are given first followed by extremes in parentheses.

Myotis lucifugus lucifugus (LeConte). Little brown bat.—Thirty-six specimens of this species were taken from Jefferson County and five from Ripley County. Measurements of 20 males are: Total length, 90.8 (87–95); tail, 38.9 (35–41); hind foot. 7.8 (7–9). Average weight is 5.4 (3.5–7.8) grams. Twenty-one females have these measurements: Total length, 92.3 (86–100); tail, 38.8 (32–43); hind foot, 8.0 (7–9). Average weight of the females is 5.6 (4.7–6.6) grams. One specimen was found crawling about inside the stovepipe of a farmhouse on May 7. The remainder were taken from caves during March, April, May and September. Collecting with shotgun at dusk failed to take this species.

Myotis keenii septentrionalis (Trouessart). Trouessart's bat.—One specimen was taken from Ripley County; fourteen from Jefferson County. Measurements of the fifteen specimens of which eleven are males are: Total length, 89.3 (86–91); tail, 39.6 (37–42); hind foot, 7.9 (7–9). Weights of nine individuals of both sexes taken in March, April and May average 4.6 (4.0–5.6) grams while those of five individuals of both sexes taken during the latter part of October average 7.3 (6.7–7.7) grams. All specimens were found hanging singly from ceilings or walls of caves or tucked in small crevices. Of the *Myotis* collected approximately one out of five belonged to this species.

Pipistrellus subflavus subflavus (F. Cuvier) and **Pipistrellus subflavus obscurus** Miller. Pipistrelle bat.—Thirty-eight specimens were taken from Jefferson County; eighteen from Ripley County. Thirty-one males average: Total length, 82.3 (75–90); tail, 37.4 (33–45); hind foot, 7.8 (7–9). Twenty-five females average: Total length, 84.4 (77–93); tail, 38.2 (34–44); hind foot, 8.4 (7–10). Weights of 18 individuals of both sexes taken in March, April and May average 4.3 (3.6–5.5) grams while those of 23 individuals of both sexes taken in June, July, September and October averages 6.2 (5.1–7.4) grams. Specimens were either shot at dusk or taken from caves where they were found hanging singly from the ceiling. A female taken on May 21 contained four 3 mm. embryos while one taken on May 27 contained two 11 mm. embryos.

The specimens in this collection can be divided roughly into three groups according to pelage: one group pale yellowish as typical *P. s. subflavus*; one group brownish as average specimen of *P. s. obscurus*; and one group intermediate in color. Handley (personal correspondence, 1955) writes, "Since extensive migrations have not been demonstrated in this species it appears more reasonable to regard variations as representing intrapopulation variation rather than interpopulation." Thus the specimens in this collection are recorded as intermediate between *P. s. subflavus* and *P. s. obscurus*; however, the coloration of the majority is nearer *P. s. subflavus* than *P. s. obscurus*.

Eptesicus fuscus fuscus (Beauvois). Big brown bat.—Thirty specimens were taken; seven from Ripley County and twenty-three from Jefferson County. In addition, data are included on 17 specimens collected from Jefferson County that were sexed, measured, weighed and released. Measurements of 18 males are: Total length 117.2 (103–127); tail, 46.2 (41–56); hind foot, 9.0 (8–10). Twenty-nine females average: Total length, 125.6 (116–137); tail, 47.8 (41–52); hind foot, 10.0 (8–12). Sixteen males weigh 13.8 (11.7–17.1) grams while 26 females average 19.1 (14.5–23.9) grams. Of interest is the comparison of data on specimens collected while hibernating with data on specimens collected during the summer. Nine females taken from caves between February 12 and March 26 have these measurements: Total length 123.6 (116–129); tail, 48.2 (44–51); hind foot, 9.4 (9–10). The weight of these nine individuals averages 16.6 (14.5–18.6) grams. Fourteen females taken on July 24 from a brood colony in the same vicinity as the above cave have these measurements: Total

length, 128.5 (121–137); tail, 48.3 (41–52); hind foot, 10.7 (10–12). These individuals weigh 20.9 (17.8–23.9) grams.

According to Lyon (Amer. Midl. Nat., 17: 1–384, 1936) *Eptesicus fuscus* is not a common cave bat in Indiana; however, the author finds this species very common in caves near the city of Madison. These bats may be seen in great numbers flying at dusk in Madison during the summer and several brood colonies are known in residences of this city. Perhaps the proximity of caves to the summer breeding colonies of this species may determine the frequency of its occurrence in caves in the winter.

For two consecutive summers a colony of this species has been observed in the rafters of a barn near Rexville, Ripley County. One female, carrying a juvenile, was taken as several bats emerged from this colony on June 1. Four single individuals were taken from cracks above cowstables in this barn; three were males.

At the suggestion of Mr. R. E. Mumford a colony of bats of this species was investigated on July 24. The colony inhabited a crevice in the floor of a concrete highway bridge on Indiana 107 near the entrance to Clifty Park. As some 50 individuals emerged 17 were caught in a net; all except three were females. Data on the females are given above.

Lasiurus borealis borealis (Müller). Red bat.—Nine specimens were taken from Ripley County; five from Jefferson County. Three males average: Total length, 102.7 (100–105); tail, 44.0 (42–45); hind foot, 8.3 (8–9). Eleven females have these measurements: Total length, 114.5 (107–120); tail, 48.6 (45–53); hind foot, 8.7 (8–10). Weight of six females averages 13.3 (11.3–14.5) grams. Females with enlarged mammae were taken on July 2, July 14, and July 15. All specimens were shot at dusk during June, July and August near farm ponds and lakes, with wooded areas nearby or in the general vicinity.

Nycticeius humeralis Rafinesque. Evening bat.—Three specimens were taken from the Rexville, Ripley County area in addition to the eight specimens previously recorded by the author from that vicinity (Lindsay, Jour. Mamm. 37: 282, 1956). All were shot at dusk near farm ponds. These three specimens, all females, average: Total length, 95.0 (92–98); tail, 34.0 (33–35); hind foot, 7.3 (7–8). Weight averages 14.5 (10.3–19.7) grams. Two were taken on June 1; one contained two 15 mm. embryos, the other a single 22 mm. embryo. The third specimen was taken on July 29. Of interest is the fact that all eight adults recorded from this area were females.—DWIGHT M. LINDSAY, *Department of Biology, Georgetown College, Georgetown, Kentucky.* *Received December 30, 1955.*

THE DISTRIBUTION OF *MYOTIS THYSANODES* IN CALIFORNIA

In 1928 Miller and Allen (U. S. Nat. Mus. Bul., 144: 127) recorded the fringe-tailed bat (*Myotis thysanodes thysanodes*) from only five localities in California. Specimens were known to them from Dulzura, San Diego County, Old Fort Tejon and Walker Pass, Kern County, and from Fyffe and Limekiln, Eldorado County. Grinnell (Univ. Calif. Publ. Zool., 40: 88, 1933), in outlining the range of this species in California, recorded it north to Stonewall Canyon, near Soledad, Monterey County. All known localities of capture were between 1,200 and 3,000 feet. Since then several additional records for *Myotis thysanodes thysanodes* within the state have appeared in the literature incidental to accounts pertaining to other species. Only one of these has appreciably extended the range of the fringe-tailed bat. Dalquest (Jour. Mamm., 28: 22, 24, 1947) records one individual of this species found in an old winery, one-half mile south of Angwin (elevation 1,750 feet), Napa County, on March 18, 1945 and a colony of about 50 adults and young found at the same locality on July 8, 1945. Donald V. Hemphill of Pacific Union College, subsequently provided the California Academy of Sciences with specimens taken at Angwin, Napa County, on the following dates: September 24, 28, 29, October 21 and February 14.

Since the species under consideration occurs in western Oregon (Roest, Jour. Mamm., 33: 346, 1952) the capture of a fringe-tailed bat (C.A.S. no. 9968♂) at Willow Creek, Humboldt County, California on September 13, 1950 by Robert R. Talmadge is not surprising. This locality is approximately 175 miles north of Angwin.

Although all of the heretofore published records for this species in California are inland

and at elevations of one thousand feet or more there is a specimen in the California Academy of Sciences (1082♂) taken on July 2, 1915 at Carmel, Monterey County, which is essentially at sea level. Furthermore, on August 8, 1954, Edith Hunter secured four specimens, 1 male and 3 females (C.A.S. nos. 10621–10624), for the writer 1 mile SSW of Woodside, 500 feet, San Mateo County.

Present evidence, therefore, indicates that in California the fringe-tailed bat is not only more abundant but more widespread, both geographically and altitudinally, than was believed a few years ago.—ROBERT T. ORR, *California Academy of Sciences, San Francisco, and University of San Francisco, California. Received January 30, 1956.*

PARTIAL ALBINISM IN *MYOTIS SODALIS*

According to Allen (BATS., 1939: 154) "A white bat occurs once in many thousand." I have been unable to find a record of a case of albinism in *Myotis sodalis* in a search of the recent literature.

On January 1, 1956, while recording banded bats in Bat Cave, Carter Caves State Park, Carter County, Kentucky, Mr. Robert G. Sagar and I collected an adult male *Myotis sodalis* exhibiting partial albinism. The skin covering the appendages including the ears and the hairless facial areas was normally pigmented as in typical specimens; however, practically all of the hairs lacked pigment. The vibrissae, the short hairs bordering the base of the interfemoral membrane, and the extreme distal tips of the guard hairs were tinged brown; all of the underfur and the proximal two-thirds of the guard hairs completely lacked pigment. Superficially the pelage resembled that of *Macrotus californicus*. The eyes of this individual were black.

Identification was based on measurements, skull characteristics, and the presence of a keel on the calcar; also the specimen was collected from a cluster of about sixty others of the same species. Measurements were taken in millimeters: length, 91; tail, 40; hind foot, 8.5; ear, 14; tragus, 7; forearm, 40; wing span, 274.

It is interesting to note that while recording banded bats in this cave on December 30, 1954, I observed a bat hanging in a cluster of *M. sodalis* with the hairs of the abdominal-inguinal region unpigmented. As I remember, the rest of the bat was normally colored. I obtained a photograph of it in situ but it fluttered away before it could be collected, and positive identification was not obtained.

These records indicate the rarity of such specimens, as perhaps a hundred thousand bats (of which *M. sodalis* comprise a vast majority) regularly hibernate in this cave. This reenforces Allen's statement (*loc. cit.*).—BRICE METZGER, *1001 S. Cassingham, Bexley, Ohio. Received January 30, 1956.*

NEW GENUS AND SPECIES, *IDIONYCTERIS PHYLLOTIS*, RECORDED FROM THE UNITED STATES

The Mexican big-eared bat, *Idionycteris phyllotis* (Allen) is one of the rarest bats in North America. Handley (Proc. Biol. Soc. Washington, 69, 1956) has reviewed the taxonomic history of the two previously known specimens. The first, secured on March 24, 1878, in San Luis Potosi, Mexico, became the type of *Corynorhinus phyllotis* as named by G. M. Allen (Bul. Mus. Comp. Zool., 60: 352, April, 1916). The second specimen, a female taken on June 17, 1922, at Miquihauna, Tamalipas, Mexico was described as a new genus and a new species under the name *Idionycteris mexicanus* by H. E. Anthony (Amer. Mus. Novitates, 54: 1, Jan. 17, 1923).

A third specimen of this species was taken on May 30, 1955, at the Southwestern Research Station of the American Museum of Natural History in the Chiricahua Mountains, Cochise County, Arizona. The Southwestern Research Station (formerly the Reed Ranch and more recently the Painted Canyon Ranch) is in a riparian community at an elevation of 5400 feet on Cave Creek. The surrounding vegetation is primarily an oak-juniper association.

With two graduate students in Zoology, Keith E. Justice and Jack Hensley, I visited

the Southwestern Research Station in late May and early June, 1955. Early in the evening of May 29, 1955, Justice, Hensley, Dr. Mont A. Cazier (director of the station) and I stretched a Japanese mist net of the type described by Dalquest (Trans. Kansas Acad. Sci., 57(1): 1–10, 1954) across the swimming pool in the front lawn of the Research Station. During the night the following species and numbers of bats were taken in the net: *Eptesicus fuscus*, 19; *Lasiurus cinereus*, 10; *Pipistrellus hesperus*, 2; *Lasionycters noctivagans*, 1; *Tadarida brasiliensis*, 20; *Tadarida molossa*, 1; and *Idionycteris phyllotis*, 1. Most of these bats were banded with size zero United States Fish and Wildlife Service bird bands and released.

Most of the bats were taken before midnight but the *Idionycteris* was captured at approximately 1:00 AM by Jack Hensley, who was still watching the net. It is an adult male, number 1763 in the Department of Zoology Museum at the University of Arizona. Measurements are: total length, 118 mm.; tail 52; hind foot, 11; ear, 40; tragus, 16; weight, 20.1 grams. The accessory basal lobes between the bases of the ears, characteristic of this genus, are extremely evident in this specimen.

Acknowledgment is made to the National Science Foundation for a research grant, G-333 (Investigations of Mammals of Arizona), that provided part of the field expenses of this trip.—E. LENDELL COCKRUM, *Department of Zoology, University of Arizona, Tucson.* *Received January 16, 1956.*

BATS FROM SAN LUIS POTOSI WITH A NEW RECORD FOR *BALANTIOPTERYX PLICATA*

On March 30, 1946, in the course of making collections of cave fish, Messrs. B. J. Dontzin and E. Ruda obtained a small series of bats from Cueva Sabinos near Valles in the Mexican state of San Luis Potosi. This locality lies in the tropical lowlands of the eastern part of the state (Dalquest, Louisiana State Univ. Studies, Biol. Sci. Ser., 1: 1–229, 1953). This collection is preserved in alcohol and has only recently been identified and catalogued at the American Museum of Natural History. Though consisting of only eleven specimens belonging to four species, it proves to be of exceptional interest from a distributional standpoint, particularly in connection with certain studies by the writer on the mammals of northeastern Mexico. I wish to thank Messrs. George G. Goodwin and Hobart van Deusen of the Department of Mammals, American Museum of Natural History for calling my attention to this collection and making it available to me. The following species are represented.

Balantiopteryx plicata.—A single male (AMNH 165637) is clearly this form. Unfortunately, though the skull was extracted, it cannot now be located. In spite of this, however, there can be no doubt of its identity, since its characters accord perfectly with those in Sanborn's key (Zool. Ser., Field Mus. Nat. Hist., 20: 321–354, 1937) and it cannot be distinguished from individuals of this species from Oaxaca and Sinaloa. The forearm measures 43 mm. The only locality on the Gulf coastal plain from which this bat has previously been reported is Puente Nacional (Davis, Jour. Mamm., 25: 370–403, 1944) in central Veracruz. The present record represents, therefore, a considerable northward extension of the known range in eastern Mexico, where it probably has a rather extensive distribution, though apparently much less common than on the Pacific side.

Artibeus jamaicensis.—The collection includes six alcoholic specimens of this form (AMNH 165541–46). There is also a skull (AMNH 165655) prepared from an embryo which, according to the original label, was found dead in a pothole within the cave. It is at just the right growth stage for the sutures between the bones to stand out most clearly. Dalquest (*loc. cit.*) has also recorded the species from Valles.

Desmodus rotundus.—The common vampire is represented by two individuals (AMNH 165638–39), a female and a young male. Dalquest (*loc. cit.*) has also recorded this form from Valles.

Diphylla ecaudata.—A single male of the hairy-legged vampire (AMNH 165640) with the skull removed and cleaned, is in the collection. It was evidently not obtained in the

cave itself but, according to the field tag, was killed while feeding on chickens. This appears to be the first record for the species on the coastal plain of San Luis Potosi, though Dalquest (*loc. cit.*) has recorded it from near Xilitla in the same state, and de la Torre (Jour. Mamm., 35: 113–116, 1954) reports on a specimen from the vicinity of El Pachon at a low elevation in Tamaulipas.—Karl F. Koopman, *Department of Biology, Queens College, Flushing, N. Y.* *Received January 17, 1956.*

THE LOSS OF EAR TAGS IN THE GRAY FOX AND RACCOON

In a study of population dynamics of the gray fox (*Urocyon cinereoargenteus*) in northwestern Florida, 145 foxes and 268 raccoons were marked and released. One hundred foxes were marked with two ear tags (National Band and Tag Co., Size No. 3) one in each ear, twenty-two foxes received two ear tags and also an ear tattoo, and twenty-three foxes received only the ear tattoo. Of the raccoons, 202 received only one ear tag and sixty-six were toe clipped (with no ear tags). Thirty-three of the 100 ear-tagged foxes were recaptured, but only twenty-three of them retained both ear tags. Ten of these foxes had lost one of their ear tags without a tear or scar visible macroscopically in the ear. Six of the tagged and tattooed foxes were recaptured and three of these retained both ear tags; but one had lost both ear tags and the other two had lost one, all again without any sign of ever having had an ear tag.

Of 202 tagged raccoons (*Procyon lotor*), 21 were recaptured, or 10.4 per cent. Eight of the 66 toe-clipped raccoons were recaptured or 12.2 per cent. This suggests that raccoons had not lost ear tags to any great extent.

Frequently, it was noticed that there was much irritation at the point where the tag passed through the ear. At the same time, there was never any sign of infection accompanying the tattoos. During the course of the study more than twenty foxes were kept in pens, all of these were ear tagged, none of them ever lost a tag and one of them experienced infection after the first few days.

Thus it is indicated that the metallic ear tag is an unsatisfactory device for the marking of wild foxes, for 33.3 per cent lost the tags. Possibly the contact with underbrush pulled out the tags.

A satisfactory substitute for the ear tag is the tattoo, which, however, supposedly lacks the attribute of attractive returnability by cooperative finders of the animals. It should be pointed out that this study produced no such cooperative finders, although at least a dozen finders of an uncooperative nature were rumored.—Rexford D. Lord, Jr., *Division of Vertebrate Ecology, Johns Hopkins University, Baltimore, Maryland.* *Received January 30, 1956.*

THE BOBCAT AS A LABORATORY ANIMAL FOR COURSES IN ZOOLOGY

Throughout large areas of the western United States the bobcat (*Lynx rufus*) is a common mammal. Since it is destroyed in large numbers by state and federal predatory animal control officers and local sportsmen, many specimens are potentially available to instructors and researchers in various fields of biology. I have used the bobcat in general zoology, comparative anatomy, and mammalian physiology courses and suggest more extensive use of this excellent biological material, in those areas where it is available.

As an almost certain source of nematode and cestode parasites it is valuable in general zoology laboratory courses, since these parasites can be demonstrated *in situ*. In the comparative anatomy laboratory the bobcat is a great aid because the structures (e.g., sympathetic nervous system, dorsal root ganglia) are much larger and more easily dissected than are those of the domestic cat. Laboratory directions for the latter are completely adequate as the anatomy of the two species is similar. Skeletons, particularly skulls, of the bobcat are preferred by students to those of the domestic cat because of their large size.

In mammalian physiology the bobcat is suitable for those experiments in which dogs are usually used, such as measurements of blood pressure by arterial cannulation, studies of respiration, and experiments on cardiac function. The animals are easily anesthetized

by intraperitoneal injection of nembutal and show remarkable vitality during surgical procedures. The large size of such structures as blood vessels and nerves greatly facilitates experimental procedures.

I have found that the use of this native wild mammal heightens student interest in the zoological principles that are demonstrated by it.—E. W. PFEIFFER, *Department of Zoology, Utah State Agricultural College, Logan. Received January 21, 1956.*

ELECTROCARDIOGRAM OF THE BOBCAT

In view of the recent interest in electrocardiograms of different mammals (Wilber, Jour. Mamm., 36: 283–286, 1955) it seems valuable, whenever possible, to obtain these data for species not previously recorded. Accordingly an electrocardiogram of a bobcat (*Lynx rufus*) was made during other physiological studies of this species.

TABLE 1.—*Electrocardiogram values for three different leads taken on the bobcat*

Lead	Rate	P-R, Sec.	Q-T, Sec.	QR, mv.	QRS, Sec.	T, mv.	T, Sec.	P, mv.
I	190	.08	.20	.12	.03	.08	.08	.03
II	190	.08	.18	1.3	.05	.4	.10	.2
III	190	.08	.20	1.1	.05	.3	.10	.13

The specimen, a young female about two-thirds grown, was anesthetized with nembutal until the corneal reflex disappeared and electrodes were applied to the skin of the right and left forelimbs and the left hindlimb. The skin was shaved and Redux paste applied to assure good conductivity. Table 1 gives the values for the three standard leads. The direction of the elextrical axis of the heart was +85 using Einthoven's triangle for the projection of the algebraic sums of R_1 and S_1, and R_3 and S_3.—E. W. PFEIFFER, *Department of Zoology, Utah State Agricultural College, Logan. Received January 21, 1956.*

THE OTARIIDAE OF THE GALAPAGOS ISLANDS

Recently Lindt (Jour. Mamm. 37: 287, 1956) published a note on the underwater behaviour of sea lions that he observed in the area of the Galapagos Islands. He referred to this animal as *Otaria jubata* (Gmelin), which is the southern sea lion and does *not* exist on the Galapagos Islands as has been pointed out by E. Sivertsen (1954) and I. Eibl-Eibesfeldt (1955). Only two species of seals have been found there by recent investigation. These are the fur seal *Arctocephalus galapagoensis* Heller and the sea lion *Zalophus wollebaeki*, which Sivertsen (1953) described as a new species. The Galapagoan sea lion has previously been referred to erroneously as *Otaria jubata* by various authors, although the two are not of similar appearance. A paper on the behaviour of this species (also dealing with underwater observations) has been published by Eibl-Eibesfeldt (Zeit. f. Tierpsychologie, 12: 286–303, 1955). Further publications: E. Sivertsen, 1953, "A new species of sea lion," Det Kongelige Norske Videnskabers Selskabs Forhandlinger, 26: 1–3; E. Sivertsen, 1954, "A survey of the eared seals (Family Otariidae)," Det Norske Videnskabs Academie i Oslo, 1954: 1–76; I. Eibl-Eibesfeldt, 1955, "Einige Bemerkungen über den Galapagos-Seelöwen, Zalophus wollebaeki Sivertsen. Säugetierkundl. Mitteilungen, 3: 101–103, and 1955, "Beobachtungen über territoriales Verhalten und Brutpflege des Galapagos-Seelöwen." Zeit. f. Säugetierkde., 20: 75–77.—IRENÄUS EIBL-EIBESFELDT, *Max-Planck-Institut für Verhaltensphysiologie, Buldern in Westfalen, Germany. Received July 12, 1956.*

EXTRA INCISORS IN THE RODENT *DICROSTONYX GROENLANDICUS*

Reports on the occurrence of extra teeth in rodents are comparatively rare, and so far as I am aware have dealt with extra cheek teeth. While examining the skulls of varying lemmings (*Dicrostonyx groenlandicus rubricatus* (Richardson)) that had died in captivity, I found one skull in which there were two incisors in the left dentary bone. Upon examination of the other dentary, it was found that it too had once possessed an additional incisor

as evidenced by an extra alveolus (Pl. I). The two incisors present in the lower jaw were different sized, the posterior tooth being normal in appearance (1.1 mm. dia.) and the anterior one being smaller (0.7 mm. dia.). The small anterior tooth possessed two worn surfaces, whereas the posterior tooth had one.

In studying the development of young varying lemmings (MS in press) I found that the incisors are puncturing the skin when young are four days old, and are prominent in animals five days old. After the incisors erupt they grow continuously for the length of the animal's life. It appears that in lemmings, other rodents, and lagomorphs, the incisors that erupt following birth are the permanent incisors and are not deciduous as in some other mammals. Presumably, the deciduous incisors of rodents are formed and absorbed during intra-uterine development. The general appearance of the extra incisor of the specimen reported herein suggests that it is a supernumerary incisor and not a persistent milk-tooth. Several young lemmings, from birth to four days of age, were dissected and showed no evidence of extra incisors. This also lends support to the theory that deciduous incisors (if present) are replaced during intra-uterine development in rodents.

It is generally accepted that deciduous teeth are rooted and do not contain permanent growing pulp cavities. For example, in pocket gophers (Geomyidae) and kangaroo rats (Heteromyidae) the first deciduous premolars are rooted, and are replaced by permanent growing teeth. When the lower dentary bones of this varying lemming are x-rayed the resultant photo shows that the extra incisor contains a pulp cavity and is permanent-growing This fact is also illustrated by the length, and wear of the tooth itself.—RICHARD M. HANSEN. *Agricultural Experiment Station, Colorado Agr. and Mech. College, Fort Collins.* *Received January 28, 1956.*

REMARKS ON REPORTED HYBRID GROUND SQUIRRELS, *CITELLUS*

Three hybrid short-tailed ground squirrels have been reported from Western United States. The first was identified as a cross between *Citellus armatus* and *Citellus beldingi*

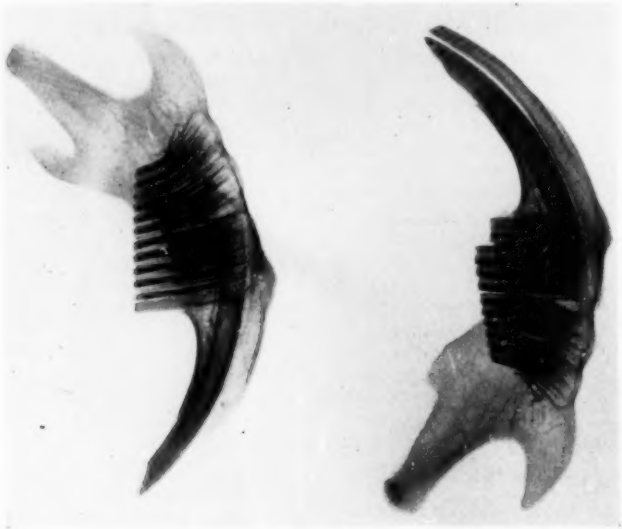

PLATE I

X-ray photograph of the dentary bones and extra incisor of a varying lemming that died when 69 days old.

(Davis, W. B., THE RECENT MAMMALS OF IDAHO, Caxton Printers, Caldwell, Idaho, 1939: 169). The other two were identified as . . . "hybrids or may be intergrades" . . . between *Citellus armatus* and *Citellus richardsoni* (Hall, Amer. Midl. Nat., 29: 378, 1943). The studies of Durrant and Hansen (Systematic Zool., 3: 82–85, 1954) on competition between species of short-tailed ground squirrels (Subgenus *Citellus*) show that animals of different species never hybridize. Moreover, at the zone of contact between colonies of any two species, the competition is extreme; the burrows and feeding areas of the animals of one species being in some instances but a few feet from those of the other species. I have collected a number of specimens from areas where the ranges of *C. armatus* overlap those of *C. richardsoni* and *C. beldingi* and have found no indication of interbreeding. In addition, I studied several hundred museum specimens of these species and found no indications of interbreeding. This prompted me to re-study the "supposed" hybrids that had been previously reported.

I thank Dr. S. D. Durrant, Museum of Zoology, University of Utah, Salt Lake City, Utah, for his supervision and suggestions during the course of this study, and for allowing me to examine the specimens in the University of Utah collection.I also thank Dr. Seth B. Benson, Museum of Vertebrate Zoology, University of California, Berkeley, California, for examining the field notes and museum records pertaining to the specimens suspected to be hybrids, and for the loan of specimens.

The specimen identified as a cross between *Citellus armatus* and *Citellus beldingi* is: Male, No. 67468, Mus. Vert. Zool., Univ. Calif., from Wickel Ranch, Elba, Cassia County, Idaho; collected by W. B. Davis July 9, 1935. Davis (*loc. cit.*) stated: "This individual resembles [*Citellus beldingi*] *oregonus* in having the lower surface of the tail reddish, and the individual hairs of the tail banded with red, black, and white. In general dorsal coloration and in most cranial characteristics it is like [*Citellus*] *armatus*." When compared with a series of specimens of *C. beldingi* from northwestern Utah and southern Idaho large enough to include all of the various colors and molts, I find that this specimen is indistinguishable from some of the lighter colored specimens. It appears to have acquired its new pelage and is similar to other "old" males from this region who molt early in the season and have a grayer colored pelage than juveniles and subadults taken at the same season. The tail is conspicuously bicolored, being chesnut-red on the ventral surface, whereas all specimens of *C. armatus* lack the bicolored tail.

The skull of specimen no. 67468 is like those of *C. armatus*, as mentioned by Davis. The skull is long and narrow and has extremely long nasal bones and is unlike most specimens of *C. beldingi* in these characteristics. The cranial measurements are: Occipito-nasal length 46.6 mm., zygomatic breadth 29.8 mm., and length of nasals 17.3 mm. However, when one compares this skull with the extremes of variation for all specimens of *C. beldingi* it is found to be within those extremes. For example, specimen number 8957, male, Univ. Utah Mus. Zool., from two miles east of Hazelton, Jerome County, Idaho, has the following skull measurements: Occipito-nasal length 47.4, zygomatic breadth 31.5, length of nasals 16.5 mm. In spite of the fact that the skull measurements are larger than specimen no. 67468 the relative proportions of the skull are like those of *C. beldingi*. Specimen no. 8962, male, Univ. Utah Mus. Zool., from 1 mile east of Eden, Jerome County, Idaho, has the following skull measurements: Occipito-nasal length 46.4, zygomatic breadth 29.9, length of nasals 17.4 mm. This skull is similar in all respects to that of the reported hybrid. Specimen no. 8954, female, Univ. Utah Mus. Zool., from 12 miles east of Hazelton, Jerome County, Idaho, possesses a skull more like that of *C. armatus* than even that of the supposed hybrid. Skull measurements of no. 8954 are: Occipito-nasal length 47.0, zygomatic breadth 30.6, length of nasals 17.8 mm. The possibility of no. 8962 and no. 8954 also being hybrids is rather remote since animals of the species *C. armatus* do not occur in the areas from which they were collected.

The specimens reported to be . . . "hybrids or may be intergrades" . . . between *C. armatus* and *C. richardsoni* are as follows. Specimen number 88988, female, Univ. Calif. Mus. Vert. Zool., from 15 miles northwest of Pinedale, 7600 feet, Sublette County, Wyoming, was collected by Donald T. Tappe August 23, 1939. The 2nd specimen (number 88989,

male, Univ. Calif. Mus. Vert. Zool.) was collected the same date by Donald T. Tappe at the same locality. Hall (*op. cit.*, p. 377) reported, "Each of the two appears to be of mixed ancestry as between *Citellus armatus* on the one hand and *Citellus richardsoni elegans* on the other hand." Hall reported that specimen no. 88988 was almost exactly intermediate in color of upper parts but nearer *C. richardsoni* in degree of coloration of the underside of the tail. The 2nd specimen (no. 88989) was reported to be almost exactly like *C. armatus* in color of upper parts, but has decided evidences of the buff characteristics of *C. richardsoni* on the underside of tail. I agree with Hall (*loc. cit.*) in his diagnosis and comparison of colors but disagree as to the genetic relationships.

Specimen no. 88988 has teeth that are mature but not worn. The pelage is new and molt is complete into subadult pelage. The subadult pelage of specimens of *C. richardsoni* from southwestern Wyoming and northeastern Utah are decidedly darker than adults. The only exception to this is found in a few specimens from the Bridger Basin of Wyoming and Utah which possess a "diffuse color" and are probably "color phases" of a local population. Those animals with diffuse color are lighter colored at all ages than normal Richardson ground squirrels. It appears to me that the intermediate color of the upperparts of specimen no. 88988 can be attributed to the subadult pelage that it possesses. The underside of the tail is also identical in coloration to that of subadult animals of *C. richardsoni* from this same general area.

Specimen 88989 is also a subadult as shown by tooth wear and pelage. This specimen is decidedly darker than specimen no. 88988 and is remarkably like those of *C. armatus* in color. The underfur is darker than in specimens of *C. richardsoni*. Upon careful examination, however, it is noted that the underfur and hairs are greasy. Upon removal of the grease it is found that the dark coloration (like *C. armatus* in appearance) is due, in part, to grease and dirt adhering to the hair. The tail of this specimen is in the process of acquiring new hair and during this stage of development the newly emerging hairs are guard hairs that are banded on their tips (Hansen, Utah Acad. Sci. Arts and Letters, 31: 57–60, 1954). This mixture of old hairs and banded tips of new hairs obscures the normally bicolored appearance of the underside of the tail.

When the skulls of specimens 88988 and 88989 are compared with the averages of *C. armatus* of comparable age from this same region the following differences are noted: Alveolar length of upper molariform teeth—*C. armatus*, 10.5 mm.; No. 88988, 9.7 mm.; No. 88989, 9.6 mm. Length of lower incisors from the alveolus to tip—10.5 mm., 9.3 mm., and 9.2 mm., respectively. Length of upper incisors from the alveolus to tip—7.7 mm., 6.9 mm. and no measurement, respectively.

In shape and outline of the rostrum it is noted that specimens 88988 and 88989 are easily distinguishable from those of *C. armatus* by having a shorter rostrum and more flaring zygoma. In this respect they are identical to subadult specimens of *C. r. elegans*.

When the extremes of variation, in age, and the state of pelage are all considered for all animals of all species, it is concluded that the three reported hybrids are all within the ranges of individual variation for the species to which they are herein assigned. The specimen from Elba, Idaho was found to belong to the species *Citellus beldingi*. The two specimens from Sublette County, Wyoming were found to be subadult *Citellus richardsoni*.—Richard M. Hansen, *Agricultural Experiment Station, Colorado Agr. and Mech. College, Fort Collins.* *Received January 28, 1956.*

LYMPHANGIOMA IN THE WHITE-TAILED DEER, *ODOCOILEUS VIRGINIANUS*

Diseases of wildlife are increasing in incidence, thus creating a problem of diagnosis and control. Many parasites are known to infest wild animals and although the literature contains many surveys of parasites affecting these animals, few studies of other disease problems can be found, except for zoo animals.

Neoplasms are being diagnosed with increased frequency in wild game, as well as in the human and domestic animal population. This report is a case history of a deer affected with a lymphangioma of the liver.

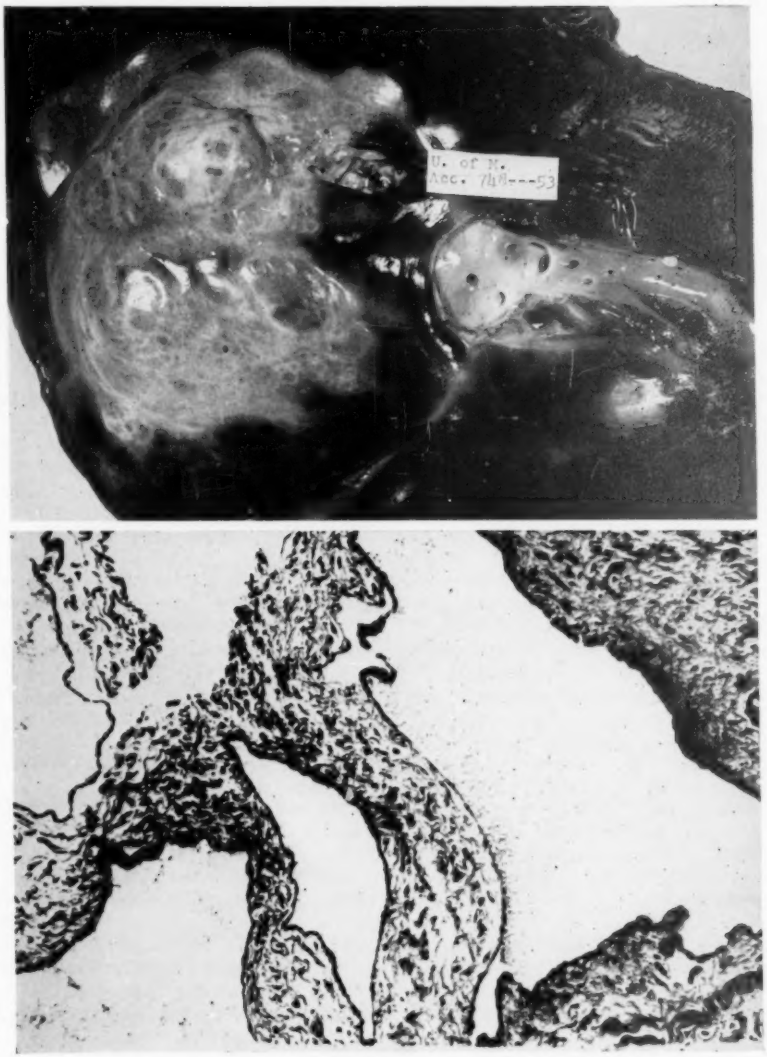

PLATE I

TOP: Gross photograph of liver showing large raised cysts. At the right of the picture an exposed vein is exhibited. BOTTOM: Low power microscopic liver photograph showing many cystic spaces containing granular material. Note the spaces are lined with a low flattened endothelial cell.

Brooks (1906) reported a few neoplasms from a large number of autopsies. Fox (1923) examined 5356 specimens of captive wild animals and birds and found a 1.7 per cent incidence of neoplasms. Myxosarcomas, carcinomas and adenomas were types of neoplasms reported. Mechanical injuries constituted over fifty per cent of the causes of death in 319 white-tailed deer autopsied over a 19 year period by Witter (1935-54). Among the remaining cases, cirrhosis of the liver was diagnosed four times, necrobacillosis twice, papilloma five times, cystichepatitis once, carcinoma twice, adenoma once and osteoma once.

Wadsworth (1954) reported a sarcoma in a deer. Quortrup (1946) reported multiple fibromas from the neck of a deer and Shillenger (1938) also observed fibromas from the Pisgah National Game Reserve. Hoover (1937) reported a neurofibromatosis neoplasm and Pocock (1915) cancer of the antlers. Winer and Schroeder (1940) reported a malignant hepatoma which is a rare carcinoma type neoplasm of animals.

Feldman (1932) in a discussion of neoplasms of domesticated animals, states that lymphangio-endothelioblastomas are new growths derived from the mesenchyme, the cells tending to line blood vessels, lymph vessels and lymph spaces. Those involving the lymph spaces and containing serous lymph-like fluid are referred to as lymphangiomas. He also cites five cases, three occurring in horses, one in a cat and one in a dog. This type of new growth is considered rare in animals. We were unable to find any reports of lymphangioma in the white-tailed deer.

We are indebted to Mr. D. C. O'Meara, University of Maine, Orono, for the photographs.

Macroscopic pathology.—The liver and heart of a deer shot during hunting season were submitted to the laboratory for examination. Numerous cyst-like structures, averaging in size 10 x 8 x 4 cm., were observed throughout the liver. These structures were raised above the surface and contained yellow to colorless viscous fluid. No other lesions were noted (Pl. I).

Microscopic pathology.—The tumor was well delineated from the parenchyma of the liver by a thick connective capsule. Spaces varying from the size of a capillary to large cavernous sinuses separated by collagenous connective tissue composed the tumor. The cells lining the spaces were elongated and flattened with a central basophilic nucleus. These endothelial lined spaces contained varying amounts of granular acidophilic material (Pl. I).

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H. L. Chute and D. M. Chamberlain, *Department of Animal Pathology, University of Maine, Orono, Maine and The Roscoe B. Jackson Memorial Laboratory, Bar Harbor, Maine.* *Received January 3, 1956.*

REVIEWS

Hall, E. Raymond. HANDBOOK OF MAMMALS OF KANSAS. University of Kansas Museum of Natural History, Miscellaneous Publications No. 7, pages 1–303, 99 numbered figures and other illustrations, December 13, 1955. Paper bound, $1.50 postpaid ($4.00 cloth).

This is one of the most complete and elaborate handbooks ever to be prepared for the mammals from one state, and treats individually 79 species of native mammals known to occur in Kansas since the advent of white man into the state. In addition, three introduced species are also considered.

Taxonomically, each kind is classified to order, family, genus and species. Appropriate keys are provided from order to species. The account of each species is headed by the common name, followed by the scientific name and author. There is a drawing of the animal immediately under the title. There then follows a section on life history, habits, behavior, economic importance, etc. This section is good and is probably the most interesting and valuable section of the book for the majority of untrained persons. Next, there is a distribution map for the state and a smaller map which indicates the range of the species in North America. A short, concise description is then provided, usually followed by drawings of different views of the skull. Finally, the account is terminated by a list of the subspecies known to occur in Kansas, with the citation of the original description and the type locality of each.

These accounts (232 pages) make up the bulk of the book. The remainder consists largely of a section (30 pages, also published as a separate) on collecting and preparation of study specimens of vertebrates, followed by a glossary and an index.

As Hall stated, this book is based largely upon Cockrum's "Mammals of Kansas" (University of Kansas Publications, Museum of Natural History, Vol. 7, pages 1–303, 73 figures in text, 37 tables, August 25, 1952). The handbook is thus the second of two books on the mammals of Kansas to appear within a period of three years from the Museum of Natural History. In addition to material from Cockrum's work, it consists principally of a compilation from many other sources. The bulk of the original contributions are incorporated in the accounts of habits, life histories, etc., and in the extensions of ranges known since Cockrum's book was published. Under the heading "Purpose and Scope," Hall indicated that the handbook was prepared primarily for persons who possessed little or no knowledge of biology, but who were interested in the mammals of the state. With this in mind, I question the necessity of so many detailed drawings of skulls, and especially those in the glossary with their details as to measurements and terms of reference. Persons with no training have little or no interest in skulls, and are primarily interested in being able to identify mammals from the skins or whole animals. To my mind, these drawings add little of value to untrained readers. Perhaps this material might have been much more profitably incorporated into Cockrum's earlier book, and would have enhanced its value greatly for serious students of mammals without detracting any from the value of the handbook for those who are untrained. It is possible that the handbook may prove too detailed for the untrained, and it will add little not already available to the trained student. I rather suspect, however, that in Doctor Hall's thinking, a handbook of this type should and perhaps will stimulate many persons to become serious students of mammals.

Generally, the book is well done; the format is good and the illustrations are clear and precise. It will be of great value to students of high schools and colleges, and to sportsmen and employees of all agencies concerned with the management of mammals of the state. The appearance of this handbook is timely because the earlier report on the mammals of Kansas has long been out of print.—STEPHEN D. DURRANT, *Department of Zoology, University of Utah, Salt Lake City, Utah.*

TRAITÉ DE ZOOLOGIE, ANATOMIE, SYSTÉMATIQUE, BIOLOGIE, vol. XVII; Mammifères, Les Ordres: Anatomie, Ethologie, Systématique, parts 1 and 2, 2300 pp., illus.; published under the direction of Pierre-P. Grassé by Masson and Co., Paris, 1955. Paper F22,000; cloth F23,600.

This seventeenth volume of the *Traité de Zoologie* is a welcome addition to the mammalogists library. In a large sense, it replaces volume 2 of Weber's "Die Saugetiere" which has been the standard reference work for students of mammals since 1928.

The general plan of treatment is, for each living order, sections on anatomy, both skeletal and soft; reproduction; systematics; and a review of the fossil members. In some instances the comments on systematics do not stop at the generic level but include species as well. For each fossil order the plan of treatment is a section on origin and affinities; anatomical characters; the dentition; and finally a section on systematics. At the end of each order is a selected bibliography pertinent to that particular group. These citations are to papers as recent as 1954 and in many cases the information has been incorporated in the text of the present work. A thirteen page addendum has been incorporated at the back of the second volume (pp. 2207–2219) in which the suborders Theridomyomorpha, Castorimorpha, and the superfamily Thryonomyoidea are described as new.

Throughout the text, use is made of the modern concept of taxonomy, yet in the arrangement of the ordinal classification the system is archaic. The terminal order is Primata of the older classifications rather than Artiodactyla or Cetacea of the modern school. This seems to be a case of ultraconservatism where the order to which man belongs, must of necessity, be the pinnacle of the evolutionary process. The suprageneric classification here adopted, is a most peculiar blending of old and new.

As might be expected, there are typographical errors, particularly in legends of figures, which, it seems, might have been reduced in number. In the section on tail autotomy in rodents, page 1331, various genera are mentioned as possessing this peculiar trait but the most notable examples, members of the family Echimyidae, have been completely overlooked.

Two new suborders Chrysochloroida and Euinsectivora; one new family, Necrolemuridae; and three new subfamilies Potamogalinae, Macroscelidinae, and Raphicerinae are proposed.

The printing and the format of the publication are excellent. The 2106 figures in the text are of the finest. The amount of information contained in these 2300 pages is staggering. Taken as a whole, this is one of the finest reference books on mammals to have been published in many years. Unfortunately the price of these two volumes makes them virtually prohibitive for an individual to purchase, but they will furnish a most valuable reference for any library that is used by mammalogists.—Henry W. Setzer, *U. S. National Museum.*

RECENT LITERATURE

(Conducted by David H. Johnson, Claude W. Hibbard, Charles P. Lyman, Richard H. Manville, and Henry W. Setzer)

[Reprints of this section may be purchased from the Corresponding Secretary]

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COMMENTS AND NEWS

HONORARIA

Two honoraria are available for the coming year for young mammalogists who have not obtained the Ph.D. degree. These honoraria carry a stipend of $100.00 each, which is to help defray the expenses of travel to the annual meetings for the presentation of the paper. This coming year the meetings will be held in Lawrence, Kansas, about the middle of June. Participants who desire to enter papers in competition, should send them to: Stephen D. Durrant, Department of Zoology, University of Utah, Salt Lake City, Utah. The deadline for receiving papers is April 1, 1957. This date is necessary in order that the papers may be read by the members of the committee in time for the successful papers to be entered on the program of the meetings.

NEW JOURNAL

Word has been received of the publication of a new journal, "Zeitschrift für Jagdwissenschaft," by Paul Parey, Hamburg, Germany. The Editor is Herrn Prof. F. Nüsslein, Direktor des Institutes für Jagdkunde, Universität Göttingen. Publication began with the 1955 volume.

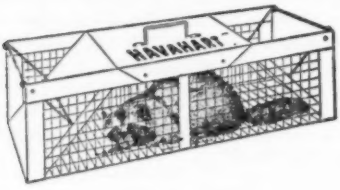
NEW RESOLUTIONS COMMITTEE

Attention of members of The American Society of Mammalogists is called to the establishment of a new Resolutions Committee. Members who expect to present proposed resolutions for action at the next annual meeting in June, 1957, are urged to send such proposed resolutions to the Chairman of the Resolutions Committee, Dr. Keith R. Kelson, National Science Foundation, Washington 25, D. C., at the earliest opportunity. The committee is anxious to submit the proposals to the members prior to the meeting but can do so only if they receive such proposals at an early date.

DATE OF ISSUE OF PREVIOUS NUMBER

Journal of Mammalogy, Vol. 37, No. 3, was mailed September 11, 1956

HAVAHART HUMANE ANIMAL TRAPS



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THIRTY-SIXTH ANNUAL MEETING

THIRTY-SIXTH ANNUAL MEETING OF THE AMERICAN SOCIETY OF MAMMALOGISTS

June 16-20, 1956

The thirty-sixth annual meeting of the American Society of Mammalogists was held at the Training School, Michigan Department of Conservation, Higgins Lake, Michigan, June 16-20, 1956.

The Local Committee on arrangements was: W. H. Burt, Chairman, Rollin H. Baker, Robert S. Butsch, Lee R. Dice, Francis C. Evans, William P. Harris, Jr., Robert T. Hatt, Don Hayne, Evan B. Hazard, C. W. Hibbard, E. T. Hooper, R. A. MacMullan, William B. McIntosh, W. B. Quay, Ed. Ray, George C. Rinker, H. D. Ruhl, Andrew Starrett, Frederick Stuewer, Oscar Warbach.

PROGRAM

SATURDAY, JUNE 16

2:00 PM—Registration

7:30 PM—Directors' Meeting, Staff Building

Movie—Life in the Arctic—Classroom Building

SUNDAY, JUNE 17

8:30 AM—Registration

10:00 AM—Morning Session

Welcome: George A. Griffith, Conservation Commission, State of Michigan.

Response: William B. Davis, President, American Society of Mammalogists.

1. Comparative histochemistry of selected tissues from active and hibernating arctic ground squirrels, *Spermophilus undulatus*. William V. Mayer, University of Southern California, Los Angeles, and the Arctic Aeromedical Laboratory, Fairbanks, Alaska.
2. Differences in behavior and temperament among races and species of *Peromyscus*. Lee R. Dice, University of Michigan, Ann Arbor.
3. The production of scientists. Keith R. Kelson, National Science Foundation, Washington, D. C.
4. Life history studies of *Pipistrellus subflavus* (eastern pipistrel) in Massachusetts. John S. Hall, University of Massachusetts, Amherst.

2:00 PM—Afternoon Session

5. A study of the spatial relationships between *Microtus* and *Blarina*. Kyle R. Barbehenn, Comparative Physiology Branch, Army Chemical Center, Maryland.
6. Fluctuations in populations of mammals according to life-zone. E. Raymond Hall, University of Kansas, Lawrence.
7. A six-year study of population variations in *Clethrionomys*. Robert S. Butsch, University of Michigan, Ann Arbor.
8. Capture probability of *Microtus pennsylvanicus* in relation to distance from center of (trap) activity. Don W. Hayne, Michigan State University, East Lansing.
9. Methods of measuring small rodent movements and densities. Daniel H. Brant, Humboldt State College, Arcata, California.
10. Some notes on the distribution of North American bats which may be involved in the rabies problem. Aurelio Malaga-Alba, Pan American Sanitary Bureau, World Health Organization, and Bernardo Villa-R., Instituto de Biologia, Mexico, D. F.

11. Observations on the biology of the bog lemming, *Synaptomys cooperi*, in southern New Jersey. Paul F. Connor, Michigan State University, East Lansing (by title).
12. Variation in growth rate of young *Microtus pennsylvanicus* in the laboratory. Theodore F. Whitmoyer and Don W. Hayne, Michigan State University, East Lansing.
13. Ecological relationships of some mammals in southeastern South Dakota. James S. Findley, University of New Mexico, Albuquerque.
14. Distribution of Canadian porcupine in the Upper Peninsula, Michigan. Frank B. Golley, Michigan State University, East Lansing.

7:00 PM—Movie, *Cottontail*, Photographed by Charles W. Schwartz, Classroom Building

MONDAY, JUNE 18

8:30 AM—Morning Session

15. Summer observations on moose behavior in Ontario. Antoon de Vos, Ontario Agricultural College, Guelph.
16. Observations on manatees in aggregations. Joseph C. Moore, American Museum of Natural History, New York.
17. Some aspects of habitat selection by the Ord Kangaroo rat (*Dipodomys ordii*). Jack M. Inglis, Agricultural and Mechanical College of Texas, College Station.
18. Some observations of habitat preferences of four species of wild mice. L. D. Frenzel, University of Minnesota, St. Paul.
19. Home range and density of small mammals. John B. Calhoun, National Institute of Health, Bethesda, Maryland.
20. An interpretation of an anomaly of the subhyoidean muscles in the dog. Howard Evans, Cornell University, Ithaca, New York.

10:30 AM—Annual Business Meeting, Election of Officers

12:00 AM—Group Photograph

2:00 PM—Afternoon Session

21. Relationships of two members of the *Thomomys bottae* complex in central New Mexico. James S. Findley and James L. Sands, University of New Mexico, Albuquerque.
22. Clinal variation in the spotted skunks of the Pacific Coast. Richard G. Van Gelder, American Museum of Natural History, New York.
23. New Tamaulipan mammal records and their bearing on the northern limits of the Neotropical Region. Karl F. Koopman, Queens College, Flushing, New York, and Paul S. Martin, Yale University, New Haven, Connecticut.
24. The distribution of certain squirrels of the Oriental Region. George H. H. Tate and Joseph C. Moore, American Museum of Natural History, New York.
25. The gray fox in North Dakota. Edmund Hibbard, North Dakota Game and Fish Department, Windsor.
26. The alleged relationship between *Petromys* and the Octodontidae. Stuart O. Landry, Jr., University of Missouri, Columbia.
27. Observations on the dolphins, *Inia* and *Sotalia*, in the Upper Amazon. James N. Layne, University of Florida, Gainesville.
28. Modern taxonomic methods, with remarks on the status of several northwest mammals. Murray L. Johnson, Puget Sound Museum of Natural History, Tacoma, and Burton T. Ostenson, Pacific Lutheran College, Parkland, Washington.
29. The possibilities of natural intergradation between the prairie and the forest deermice. Kyle R. Barbehenn, Comparative Physiology Branch, Army Chemical Center, Maryland, and John G. New, Department of Conservation, Cornell University, Ithaca, New York.

6:00 PM—Annual Banquet, Shore of Higgins Lake

8:00 PM—Vanishing Large Mammals of Asia and Africa, by Lee Merriam Talbot, International Union for the Protection of Nature, Classroom Building

TUESDAY, JUNE 19

8:30 AM—Morning Session

30. A technique using dyes for studying the movements of small mammals. John G. New, Cornell University, Ithaca, New York.
31. A new method for determining movements of small mammals. C. H. Conaway and John Esther, University of Missouri, Columbia.
32. Studies on the structure and function of the pineal organ in mammals. W. B. Quay, University of Michigan, Ann Arbor.
33. A preliminary report on the hormonal control of the vulva in *Dipodomys*. E. W. Pfeiffer, Utah State Agricultural College, Logan.
34. Reproductive activity in subadult cottontail rabbits (*Sylvilagus floridanus mearnsi*) in Ohio. Norman C. Negus, Tulane University, New Orleans, Louisiana.
35. Laboratory detection of reproductive isolation in *Peromyscus*. William B. McIntosh, University of Michigan, Ann Arbor.
36. Prenatal survival and loss in some cricetid rodents. James R. Beer, University of Minnesota, St. Paul.
37. A population study of big game animals in East Africa. George A. Petrides, Michigan State University, East Lansing.
38. Mammal studies in southern Africa. J. Meester, University of Michigan, Ann Arbor, and Transvaal Museum, Pretoria, South Africa.
39. Mammalian ecology and systematics in the Belgian Congo. P. Pirlot, Instut Recherche Scientifique, Belgian Congo, Africa (by title).

2:00 PM—Final Business Meeting and Afternoon Session

40. Should bird bands be used on bats? Harold B. Hitchcock, Middlebury College, Middlebury, Vermont.
41. Some band returns on Mexican freetail bats banded in Oklahoma. Bryan P. Glass, Oklahoma Agricultural and Mechanical College, Stillwater.
42. Molting periods in the eastern chipmunk, *Tamias striatus*. Dana P. Snyder, University of Massachusetts, Amherst.
43. Observation on winter activity of red squirrels in Interior Alaska. William O. Pruitt, Arctic Aeromedical Laboratory, Fairbanks, Alaska.
44. Some aspects of gray squirrel behavior. Arnold Bakken, Wisconsin State College, Eau Claire.
45. A spectrophotometric analysis of melanism in a dark-lava population of *Neotoma albigula* in southern Arizona. Keith E. Justice, University of Arizona, Tucson. (This paper was awarded an honorarium).
46. A population study of the Rocky Mountain Bighorn Sheep (*Ovis canadensis canadensis*) Shaw on Wildhorse Island. Herman A. Ogren, University of Southern California, Los Angeles. (This paper was awarded an honorarium).

WEDNESDAY, JUNE 20

8:30 AM—Checkout

DIRECTORS' MEETING

The meeting was called to order by President William B. Davis. Reports ot the Corresponding Secretary, Treasurer, Auditors, Trustees, and Index Committee were read and approved. Lee R. Dice was unanimously nominated for honorary membership. The report

of the Editorial Committee, including the resignation of the Editor, W. R. Eadie, was accepted and approved. The directors voted in favor of reaffiliation with the AIBS, at the associate-member level. Harris was reappointed to succeed himself as Trustee. The sums of $2,100.00 from the Endowment Fund and $600.00 from the J. A. Allen Memorial Fund were transferred to the Treasurer of the Society for publication of the Journal. A committee composed of Kelson (chairman), Hooper, Hoffmeister, and Schantz was appointed to consider the feasibility of combining the offices of Corresponding Secretary and Treasurer, and further to consider the possibility of organizing a more efficient procedure for conducting the Society business. The committee was given six months in which to prepare a report. Matters pertaining to raising of dues, adoption of a budget, selection of an Editor, reorganization of editorial procedure, and possible selection of a new printer were deferred to a special meeting of the Directors.

SPECIAL MEETING OF BOARD OF DIRECTORS

Richard H. Manville was appointed Editor-in-Chief, to assume his duties effective January 1, 1957, and was empowered to appoint up to five Associate Editors. Some names were recommended as possible Associates. Transfer of the printing of the Journal of Mammalogy from the Waverly Press to the Allen Press of Lawrence, Kansas, was approved after completion of the current volume. The outgoing and incoming Corresponding Secretaries were empowered to dispose of excessive numbers of back issues of the Journal by any expedient means. The name of Albert R. Shadle was unanimously placed in nomination for honorary member. The following budget for 1956 was approved:

Expenses of the Journal of Mammalogy	$9,500.00
Expenses of the Treasurer	250.00
Expenses of the Corresponding Secretary	450.00
Expenses of the Membership Committee	50.00
Expenses of the Editor	300.00
Zoological Record	100.00
Contingent Fund	250.00
Honoraria for young mammalogists	200.00
Index Committee	10.00
A. I. B. S.	100.00
Total	$11,210.00

Action on raising of dues was deferred until the 1957 meeting.

ANNUAL BUSINESS MEETING

The first session of the annual business meeting was called to order with 82 members present. Reports of the Corresponding Secretary and Treasurer were read and approved. A list of 139 names were presented to the Society for election to membership. The following officers were elected: William B. Davis, President; Robert T. Orr and Stephen D. Durrant, Vice-Presidents; Randolph L. Peterson, Recording Secretary; Bryan P. Glass, Corresponding Secretary; Caroline A. Heppenstall, Treasurer. Directors elected to the 1956-1958 term were: W. Robert Eadie, Donald Hoffmeister, Bernardo Villa-R., Rollin H. Baker, and Antoon de Vos.

The report of the Trustees was presented to the Society and approved with thanks. The reports of the Bibliography Committee and Editorial Committee were read and approved. Keith E. Justice and Herman A. Ogren, winners of the 1956 awards to young mammalogists were introduced to the Society.

The following summary of memberships and subscriptions was presented by the Corresponding Secretary for the years 1954 and 1955:

	1954		1955	
Membership				
Changes since last report				
Nominees		116		124
Resignations	26		31	
Deaths reported	8		8	
Dropped (delinquent)	65		85	
	99	116	124	124
Status as of December 31, 1955				
Honorary members		9		9
Life Members		71		73
Annual Members		1360		1360
Total Membership		1440		1442
Subscriptions				
Changes since last report				
New subscriptions		55		38
Subscriptions cancelled	72		18	
Net change		−17		20
Total paid subscriptions		427		447
Mailing List				
Total membership		1440		1442
Members not receiving Journal		160		116
Total members receiving Journal		1280		1326
Total paid subscriptions		427		447
Total mailing list		1707		1773
Net change		6		65

The Society learned with regret of the deaths of eight members, including both life members (†) and charter members (*): Charles C. Adams*, Fisher C. Bailey, Albert E. Coburn†*, George L. Harrison*, Stanley G. Jewett*, Gardiner F. Jones, Morris M. Green†, and Lowell Storrs Miller.

The final session was convened with a total of 80 members present. The names of Lee R. Dice and Albert R. Shadle were presented to the Society for election to Honorary membership and were elected with a standing ovation. Reports of the following committees were read and accepted: Membership (Albert R. Shadle); Conservation of Land Mammals (read by Antoon de Vos); Marine Mammals (Robert T. Orr); Nomenclature (E. Raymond Hall); Index (Viola S. Schantz).

Lawrence, Kansas, was selected as the site for the 1957 meeting, the time to be in mid-June.

Reports from the National Research Council (Keith R. Kelson) and the International Union for the Protection of Nature (E. Raymond Hall) were presented.

The Resolutions Committee (Donald Hoffmeister) asked that the following information be noted by the membership: Representatives of many scientific disciplines have visited the U.S.S.R. and many Soviet scientists have visited the U.S., although few if any mammalogists have entered into such an interchange. The Soviet Embassy at Washington, D. C., has stated that Soviet scientists would welcome an exchange of mammalogists, which should be made through the Zoological Institute of the Academy of Sciences of the U.S.S.R., Moscow. The U.S. State Department approves the visit of mammalogists to the Soviet Union, but arrangements must be made directly with the Soviet Government as a private American citizen and outside the program of formal exchanges, as at present these are confined to the fields of agriculture and medicine.

The Resolutions Committee recommended that the 1955 resolution on the Wichita Mountains Wildlife Refuge be reaffirmed and copies forwarded to the appropriate persons. The following resolutions were presented and adopted: WHEREAS plans are being considered for deproclaiming all of the central portion of Serengeti National Park, retaining only Ngorongoro Crater on the east and a widely-separated area of bush on the west, and
WHEREAS this action if carried out would extinguish any opportunity of preserving one of the greatest remaining aggregations of African wildlife with dubious permanent benefit to the native people, and
WHEREAS summary annihilation of Serengeti National Park would lead inevitably to the weakening of the wildlife preservation structure throughout the British sphere of influence on the African continent,
THEREFORE, be it resolved that the American Society of Mammalogists requests that Her Majesty's Government and particularly the Ministry for Colonies and Native Affairs give this matter the most serious study in order to find alternate means for assisting the natives without affecting the usefulness of Serengeti National Park as a wildlife sanctuary.
(II) WHEREAS the Bighorn Sheep, *Ovis canadensis*, was first described to science from specimens taken near the present site of Exshaw, Alberta, by MacGillivray in 1801, and
WHEREAS a small band of bighorn has continued to exist at the type locality, which was included in Kanaskis Game Preserve, and became very tame, and
WHEREAS it has been learned that the Preserve has been opened to hunting and the sheep band may be exterminated,
THEREFORE, be it resolved that the American Society of Mammalogists deplores the opening of hunting on this particular band and requests that an attempt be made to give local protection to this band.
(III) WHEREAS the U.S. Fish and Wildlife Service and Alaska Game Commission have aided in the protection of the wolverine in Alaska by classifying it as a fur-bearing animal and thus circumvented the Territorial bounty, and
WHEREAS the U.S. Fish and Wildlife Service continues to expend great sums of public money in Alaska for the airplane hunting and poisoning of wolves, without having conducted a thorough and comprehensive study on the effects and importance of predation by wolves on the caribou and moose,
THEREFORE, be it resolved that the American Society of Mammalogists commends these organizations for their courageous stand in affording all the protection within their power for the wolverine in Alaska, and
be it further resolved that the Society recommends that a comprehensive research program on the inter-relationships of wolves, caribou and moose in Alaska be initiated and that serious consideration be given to the proposal that the public funds now allocated for wolf control in Alaska be used for such research.
(IV) WHEREAS the Michigan Department of Conservation and various members of the University of Michigan, Michigan State University, and Cranbrook Institute, by providing facilities, entertainment, generous hospitality, and untiring efforts, have contributed greatly to the success of the Thirty-sixth Annual Meeting of the American Society of Mammalogists in session at Higgins Lake, Michigan, June 16–20, 1956.
THEREFORE, be it resolved that the Society extends an expression of its thanks and hearty appreciation to the Department of Conservation, particularly to Mr. Ed. Ray, Superintendent of the Training School, and Mr. Harry D. Ruhl, Chief of the Game Division, and to the entire Local Committee, particularly its chairman, William H. Burt.

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